SCIENTIFIC AMERICAN SUPPLEMENT. No. 974

Copyright by Munn & Co., 1894.

Scientific American Supplement, Vol. XXXVIII. No. 974. | NEW YORK, SEPTEMBER 1, 1894. | Scientific American Supplement, $5 a year.
Scientific American, established 1845. | | Scientific American and Supplement, $7 a year.

A VISIT TO THE SLATE QUARRIES OF ANGERS.

AMONG the excursions, often very picturesque, that can be made into the subterranean world, one of the most original, and about the most exciting, is a descent into the slate quarries of Angers. The special character of this mine visit is connected with the method of exploitation by immense chambers that has been applied at Angers from time immemorial. But (and this is what gives the subject a sort of actuality) it will be well just now to make haste, if one desires to enjoy this spectacle, since the ancient method of work, which was attended with serious danger to the laborers, will perhaps soon disappear. The evolution, begun a few years ago, may be precipitated some day or other in the train of legislative prescriptions, and we shall then no longer see any method employed in the quarries except the one that is probably safer, and certainly much more curious, called the ascending.

The argillaceous schists of Angers form, in the midst of the Silurian formation to which they belong, several almost vertical strata (called veins in the country) of variable thickness, exceeding 300 feet in places. It is these so-called veins, and more especially their most homogeneous and fissile portions, that it is a question of extracting from the earth in great blocks in order to split and shape them—the large pieces for billiard tables, mantelpieces, etc., and the smaller ones for the covering of roofs. As the price of the large pieces goes as high as about a dollar per square foot, while the slates for roofing have descended to less than twenty cents a thousand, it is very important that the dimensions of the blocks shall be reduced as little as possible, in taking into account their natural joints. This leads to the brilliant lighting of the working points by electricity and contributes to the peculiar character of the operations.

These joints and fractures of the schists, of which one constantly hears spoken in the Angers quarries, bear a series of old and more or less strange names (torsins, cordes de chat, chefs, bavures, crusses, etc.), as to the precise signification of which one is not always absolutely agreed, but which have nevertheless played a great part in all the discussions relative to the changing of the method of work. These joints have not only an influence, which would be of secondary interest, upon the division of the blocks and their utilization, but they also have the effect, if care be not taken, of leading to the sudden sliding of huge masses of slates, and, sometimes, as a too frequent consequence, to the disastrous burying of a whole brigade of laborers.

The methods of exploitation applied at Angers are three in number: (1) The method by cuttings in the open air used from the twelfth century up to 1832, but now more and more restricted in measure as one is led, through the exhaustion of the outcroppings, to exploit the deeper and deeper parts of the deposit. (2) The method called descending, by large chambers lighted with electricity, fully 300 feet in length and 325 in height, and the first application of which was made in 1832 at the Grands-Carreaux, upon the advice of Mr. Le Chatelier. (3) Finally, the new method, called the ascending, in which the excavations are filled in in measure as the work progresses, as is generally done in coal mining.

We shall say but a few words as to these two latter methods, of which the two accompanying figures give the aspect and arrangement. The open cuttings of from 130 to 160 feet in depth, which generally strike visitors ignorant of the art of mining with astonishment, have often been described, and, moreover, present nothing more extraordinary than do numerous other exploitations of the same nature in metalliferous deposits: Dannemora in Sweden, Rio Tonto in Spain, Mokta-el-Hadid in Algeria, etc. The first engraving represents a chamber of subterranean exploitation of the Hermitage slate quarry. This chamber, which is being deepened more and more at the base, may be, perhaps, 300 feet in height, with a rectangular section of 100 by 180 feet. The very great resistance of the schist permits of forming these immense and nearly vertical walls without very serious danger and of preserving as a vault, during the entire duration of the exploitation, one and the same horizontal rock surface. But, in order to prevent the falling of blocks from such a height upon the laborers at work below, it is necessary to keep a close watch over these slate surfaces. This is the object of the flying bridges that are seen crossing the chamber lengthwise and breadthwise near the ceiling, and which are suspended in space by iron rods fixed in the slate, and are reached through vertical ladders inclosed here and there in wooden cases that form a sort of landing places.

GENERAL VIEW OF THE SLATE QUARRY OF ANGERS.

1. Descent of the car. 2. Work in the chamber.

Walking over these frail bridges, suspended by rods that oscillate at every step, cannot be done without some perturbation by those who are subject to vertigo. When blasts are fired below, one feels the mass of slate vibrating violently and for a long time, and if he is not yet hardened to this sort of impression he may imagine that the rods, which are perfectly solid, are about to give way and precipitate him from a height of over three hundred feet.

The view obtained from any one of these bridges is very curious. At the back of the immense chamber with shining black walls illuminated by the theatrical light of the electric beacons, one distinguishes through a vague cloud of dust the pygmy laborers, who by pick and jumper are getting out blocks of slate by stopes of from 10 to 13 feet in height, in starting, to the right and left, from a trench previously excavated below in the axis. In a corner of the ceiling, a round aperture, like a cellar window, allows of the entrance of a wide beam of daylight in which operates the hauling box that carries up the slate or serves for the ascent and descent of the laborers.

It is through this aperture, the bottom of a shaft four hundred feet in depth, that one enters the quarry, as if through the neck of a bottle, and this descent would of itself pay for the visit. The hauling box is a sort of round bucket suspended by three chains from a pulley which is itself attached to a steel cable and rolls over a guide cable that extends from the exterior surface to the bottom of the chamber. Three men take their place in a standing position in the box, in balancing themselves and holding each of the suspension chains with the hand. Then the apparatus begins to move, and, in the first place, descends four hundred feet in the moss-covered shaft, at the bottom of which, in describing a curve of wide radius due to the flexibility of the guide cable, it suddenly enters the subterranean chamber. A person then has the sensation, which he never experiences in an ordinary mine shaft, of being absolutely lost in space above a strongly lighted abyss where he observes men in motion three hundred feet beneath him. Meanwhile the box is sliding down the undulating guide cable, and, in a few minutes, one is at the bottom, surrounded by laborers who have a load of slate all ready to be sent up by the same route.

This box is a dangerous device, both by reason of the breakages that may occur in the carrying cable, which is ever ready to wind around the guide cable, and the liability of fragments of schist to fall upon the head of the laborers at the bottom during the ascent of the box.

In a general way, moreover, the exploitation of slate quarries is one of the most murderous of the mining industries. In 1892, a year that was not marked by any great accident, six men out of the 794 employed at the bottom were killed, say a proportion of 7·56 per 1,000, while in the same year the proportion in coal mines was but 1·18 per 1,000 (112 killed out of 95,000 laborers at the bottom), and, in all the mines and quarries of France, 1·09 per 1,000 (287 killed out of 262,348 laborers).

This proportion explains why it is that so earnest an endeavor has been made to find a less dangerous method of exploitation. The system selected, which was at the beginning very vigorously discussed and is still rejected by the principal body of quarrymen called the Commission of the Slate Quarries of Angers, is the one called the ascending method.

In the preceding method of work it will be seen that the laborers constantly extract the slate under their feet in chambers that deepen indefinitely. In the ascending method, a beginning is made, on the contrary, by proceeding by means of a shaft to the lowest point that it is desired to exploit, and from there rising progressively toward the surface in extracting the slate and gradually filling in the space below with material let down from the surface for that purpose.

One will at once see the advantage of the system, which is the suppressing of immense walls difficult of surveillance, especially vertical ones, which are really much more dangerous than the horizontal ceiling, since, if there be some concealed joint therein, the whole mass of superposed slate may some fine day slide over such polished joint, and advancing into space, fall into the chamber. At the same time, the hauling box is suppressed; but, per contra (and this is what has created very resolute adversaries of the new method), instead of the well known and well watched fixed ceiling, we have one that is incessantly variable and shaken by blasts; and, for the convenient exploitation under foot is substituted the difficult work above upon movable scaffoldings, so that very sound minds, while favoring the extension of this system, are still fearful that the number of great accidents will be

diminished only to singularly increase that of the minor ones. Experience, nevertheless, seems to pronounce rather in favor of the ascending method, which is applied with large chambers of feeble height at the Grand'Maison and with small chambers previously surrounded by a system of galleries at the Foret.

Fig. 2 shows how the operation is performed at the Foret, in excavating successively, starting from the bottom and for the entire width of the chamber, a series of trenches 12 feet in depth. Above, upon a platform suspended from the slate roof by iron rods, men are seen boring blast holes. Beneath them may be seen the front of the 12 foot cutting, which gradually recedes in measure as the work goes on. Lower still, a dark band represents the upper part of the space created by the exploitation of the lower section already removed, the rest of the space having been filled in with material that forms the floor, and upon this material there rests to the right a large block of slate that, after being divided into sufficiently small pieces, is to be carried away upon a small platform car moving upon rails. Here, again, the lighting is done by electricity, through incandescent lamps suspended by a cord and that are lifted to the ceiling by pulleys before a blast is fired.

After the blocks of slate have been extracted by any of these methods and raised to the surface, it remains to shape them.

The working of the slate for roofing must be done in situ before the material has dried, and, in losing its water, has lost also its fissility. The block is first slit into thick plates by means of a chisel. Then the slitter, seated under a wind screen, his feet incased in thick sabots and his legs wrapped with rags to prevent him from wounding himself, places the fragment of schist between his legs, and, provided with a very thin chisel and a mallet, strikes the edge in order to detach sheets from it. All that has to be done then is to give this sheet its proper form and size. This is done by means of a plane iron—a very heavy iron knife, whose extremity is shored into a ring and which turns down against the edge of a block.

The laborers are so used to this work that they perform it very rapidly, and at the rate of from 700 to 800 slates per day. But the more the dimensions of the slate are increased (as is now the tendency in order to compete with machine-made tiles), the more delicate the operation becomes; and this question of large sized slates, called the "large English," is a source of frequent conflicts between bosses and workmen. It is estimated that an outside laborer earns from fifty-five to seventy cents a day, and a pitman from sixty to eighty cents.

There might be still much to say about the curious working costumes that have been perpetuated at Angers from the middle ages up to recent years, and are but slowly disappearing one by one; but this is a subject that we do not wish to touch upon here, and we shall content ourselves with a few statistical figures for finishing this curious study.

In 1893, the slate quarries of Maine-et-Loire gave employment to 1,034 inside and 2,185 outside laborers—say altogether 3,219, of whom 1,511 were slitters. In 1891 a total of 2,749 was divided into 2,121 for the center of Angers (Trelazé), 109 for the Foret and 135 for Misengrain. During the year these 2,749 laborers produced 159,820,047 slates, worth $710,650.

The figures of 1893 correspond to a certain revival in this industry, which for some years previous had undergone a crisis due especially to the competition of machine-made tiles. As a sequel to the reduction in the production, it has been possible to raise the price slightly.—La Nature.

GRADUATE AND POST-GRADUATE ENGINEERING DEGREES.*

By Prof. GEO. F. SWAIN, Mass. Inst. Technology, Boston.

BEFORE considering the engineering degrees, it is desirable to understand clearly that such a degree simply represents that the holder has passed successfully through a certain prescribed academic course. A diploma is a certificate of work done—nothing more. It is neither a certificate of character, a guarantee of ability to enter at once upon responsible work, nor a recommendation; for any school is likely to award its diploma to men who, while they may have completed the prescribed course, are not such men that the members of the faculty might individually be willing to recommend them. Of course, if a school requires a high standard of scholarship and morals, and if the daily work of the students is rigidly scrutinized, a four years' course will generally result in weeding out the poor men, so that the diploma of such a school will be looked upon as a recommendation of the person holding it. This, however, is an inference from the degree, and not a characteristic of the degree itself.

If, then, a diploma simply represents a certain amount of academic work done, it seems desirable that the form of degree should clearly indicate this fact, and should not be a degree that is liable to be confused with the simple name of a profession or occupation.

Engineering degrees are of three kinds. First, we have the degrees bachelor of science or of philosophy (S.B. or Ph.B.) for undergraduate degrees, and the post-graduate degrees master or doctor of science or of philosophy (M.S., S.D., or Ph.D.) These all correspond to the established classical degrees which have come down to us from the middle ages or from earlier times—bachelor of arts or "artium baccalaureus" (A.B.); master of arts, "artium magister" (A.M.); doctor of medicine, "medicinae doctor" (M.D.), and so on. These degrees have no meaning except as academic degrees, and they are recognized at once as such.

Second come the so-called descriptive degrees, which are simply names of the professions for which the holders are supposed to be fitted, such as "civil engineer" (C.E.), "mechanical engineer" (M.E.), "electrical engineer" (E.E.), and others.

These descriptive degrees appear much less suitable than degrees of the first class, for the following reasons. In the first place, they are not in line with the old established classical degrees, and it is desirable that all degrees should be on some uniform basis. It is inconsistent for a university to give the degree A.B. ("artium baccalaureus") in its classical course and C.E. in its engineering course. In the second place, the multiplication of descriptive degrees leads to confusion. Shall the degree for a course in chemistry be simply "chemist" (C.), and in achitecture "architect" (A.)? It would be just as reasonable to give different degrees in medicine, and to give to John Smith the degree E.D. (eye doctor), or to Thomas Jones the degree L.D. (lung doctor). In the third place, the degrees like C.E. are liable to abuse, and many practitioners write these letters after their names, either for convenience as an abbreviation simply or with intent to deceive. There is no temptation to wrongfully appropriate the degree S.B. In the fourth place, no academic course can make a man an engineer, so that the degrees C.E. and others like it involve a contradiction in terms. All engineering courses are principally courses in science—in the scientific principles underlying the engineering professions; and the degree in science appears in all respects the most suitable. Thus the graduate in civil engineering would be bachelor of science in the department of civil engineering. Another class of degrees includes those like bachelor of civil engineering (B.C.E.) These degrees obviate many of the objections to the simple C.E. degree, but appear less suitable than the simple science degrees, and they involve confusion and a multiplicity of titles, if applied to all the technical professions.

In some schools the baccalaureate degree is S.B. or Ph.B., while C.E. is given after a certain amount of practical experience. This last degree is, therefore, really an honorary degree, as it is not based on academic work done at the institution. The writer believes that we should be much better off with no honorary degrees whatever, that all degrees should represent actual work done at the school or under its direction, and that the honorary degrees are liable to much abuse, because indiscriminately awarded.

The author concludes that there is no consistent or reasonable ground for the descriptive degrees, and that the proper engineering degrees should be bachelor of science and doctor (or master) of science, or doctor of philosophy.

* Abstract of a paper read before the American Association, Brooklyn, 1894.

GRADUATE AND POST-GRADUATE DEGREES.*

By Dr. R. H. THURSTON, Director of Sibley College, Cornell University.

THE author thought the form of degree to depend, in fact, upon the nature of the course, the logical relations of title to course and to vocation, and to the question of expediency. He refers to three classes of so called technical and engineering schools—those in which some applied science is taught with much of pure science and of literature; those in which a professional course is aimed at, but which, nevertheless, are compelled to do some educational work in literature and in science; those in which, as in law schools, preparatory professional work only is performed. The last only he calls real professional schools—the ideal type at which all aim, but to which few, if any, attain.

In the first two, the work is mixed, partly "educational," partly "professional." In the latter it is assumed that the student is educated as well as his means and his time may permit before coming to the professional school. The author thinks the degree itself to have little intrinsic importance, that the course is the main thing, but that the older form, as B.S., may well suit the first case, the professional form, as C.E. or M.E. the third type of school, and the intermediate schools may be in doubt. He has observed that the men receiving degrees prefer the professional form; but the whole matter assumes less and less importance with him, as he finds, on entrance into professional life, that no one asks to see his diploma, or inquires about its particular form.

* Abstract from remarks made before the American Association, Brooklyn, N. Y., 1894.

ABSTRACT of a paper on Graduate and Post-Graduate Engineering Degrees, by Professor Palmer C. Ricketts, Rensselaer Polytechnic Institute:

A degree conferred at the conclusion of a prescribed course of study merely signifies that the course has been finished to the satisfaction of the corporation conferring it. Therefore, it seems appropriate to use that succession of words for the degree or that succession of letters for its abbreviation which most nearly indicates the character and object of the curriculum. Since engineering schools generally confer the degrees C.E. and M.E., there seems to be no reason to change.

The course, and not the degree, counts, and after a professional man has had some experience and become a member of a recognized engineering society, he very seldom uses the degree obtained from the school, but uses the abbreviations of the professional society.

[NAUTICAL MAGAZINE.]

GREAT CIRCLE SAILING.

UP to the present time, the practical solution of the problem of great circle sailing has not been required for even the extra certificate at the Board of Trade. In view, therefore, of its introduction into the proposed examinations in Captain Beall's new syllabus, and from the prominent place the subject has occupied in the navigation papers of the Science and Art examinations of this year, I may not be out of season in submitting a method of finding the great circle distance which requires fewer figures than the methods given in Raper and Norie, but it is to be found in the last edition of Merrifield's "Treatise on Navigation." Beginning with the investigation of the rule:

Let d = the great circle distance.
" p = the difference of longitude between the two places.
" λ = the greater colat.
" l = the lesser colat.

Then,

$$\text{Cos d} = \cos \lambda \cos \text{l} + \sin \lambda \sin \text{l} \cos \text{p} \quad \ldots\ldots (1)$$

Assume that

$$\text{Cos l} = \text{k} \cos \text{N} \quad \ldots\ldots (2)$$

$$\text{Sin l} \cos \text{p} = \text{k} \sin \text{N} \quad \ldots\ldots (3)$$

Satisfy the conditions of equation (1)

Eliminate k by dividing equation (3) by equation (2) and we get:

$$\text{Tan N} = \tan \text{l} \cos \text{p} \quad \ldots\ldots (4)$$

From equation (2) we get:

$$\text{k} = \cos \text{l} \sec \text{N}.$$

Substituting in equation (1) the values in (2) and (3), we get:

$$\text{Cos d} = \text{k} (\cos \lambda \cos \text{N} + \sin \lambda \sin \text{N}).$$
$$= \text{k} \cos (\lambda - \text{N}).$$

Therefore,

$$\text{Cos d} = \cos \text{l} \sec \text{N} \cos (\lambda - \text{N}).$$

Or,

$$\text{Cos d} = \cos \text{l} \sec \text{N} \cos (\lambda \pm \text{N}) \quad \ldots\ldots (5)$$

The double sign in the expression ($\lambda \pm$ N) signifies that when the difference of longitude between the two places exceeds 90°, the auxiliary angle or arc N is to be added to the colatitude λ, but if the difference of longitude is less than 90°, N is to be subtracted from the colatitude λ.

The courses may be readily obtained by the ratio existing between the sines of the sides and the sines of the angles in a spherical triangle.

If we designate the course by C we have:

$$\text{Sin C} = \sin \text{l} \sin \text{p} \operatorname{cosec} \text{d},$$

which gives the course from the place of greater colatitude to the place of lesser colatitude reckoned from the same pole,

$$\text{Sin C} = \sin \lambda \sin \text{p} \operatorname{cosec} \text{d},$$

gives the course from the place of lesser colatitude.

We may now put equations (4) and (5) into a form for calculating by logarithms and introduce a numerical example.

Find the great circle distance from Swan River, lat. 32° 3' S., long. 115° 45' E., to the Cape of Good Hope, lat. 34° 0' S., long. 18° 30' E.:

	C. G. Hope.		Swan River.	Long.
Lat.	34° 0' S.	Lat.	32° 3' S.	115° 45' S. River.
Colat.	56° 0'	Colat.	57° 57'	18° 30' C. G. H.
			Diff. long.	97° 15'
Colat. l	= 56° 0'	tan 0·17191		cos 9·74756
Diff. long. p	= 97° 15'	cos 9·10106		
Arc N	= 10° 36'	tan 9·27305		sec 0·00747
Colat. λ	= 57° 57'			
(λ + N)	= 68° 33'			cos 9·56311
		d = 78° 0'		cos 9·31814
		60		
Great circle distance		= 4680 miles.		

If the sum or difference of the auxiliary arc N and the greater colatitude exceed 90°, take the supplement of d found for the cosine and reduce it to minutes of arc for the distance.

Example.—From East Cape, New Zealand, lat. 37° 40' S., long. 178° 36' E., to San Francisco, lat. 37° 48' N., long. 122° 24' W. Find the great circle distance.

Taking the North Pole for the colats.

East Cape, lat.	37° 40' S.	San F. lat.	37° 48' N.	Long.
	90°		90°	178° 36' E.
Greater colat.	127° 40'	Lesser colat.	52° 12'	122° 24' W.
				301° 0'
				360°
			Diff. long.	58° 0'
Colat.	52° 12'	tan 0·11082	cos	9·78739
Diff. long.	58° 0'	cos 9·71184		
N = Colat.	33° 35' / 127° 40'	an 9·82216	sec	0·07931
Diff. =	94° 5'		cos	8·85252
	d = 87° 0'		cos	8·71922
	180°			
	93° 0'			

Great circle dist. = 5580 miles.

The geometrical meaning of the auxiliaries k and N is, k is the cosine of the perpendicular let fall from the place of lesser colatitude upon the meridian of the place of greater colatitude, and N is the arc intercepted between the pole and the perpendicular of which k is the cosine, which may be readily verified by the construction of a freehand figure.

T. MACKENZIE, F.R.A.S.

THE COST OF THE NEW NAVY.

WHEN the vessels which are now in process of construction are completed, the new navy of the United States will consist of forty-five vessels ranging in size from the great battle ship Iowa of 11,300 tons down to the torpedo boat Ericsson of 120 tons displacement. For the following particulars in regard to the cost of the vessels, their speed premiums, etc., we are indebted to the New York Times:

		Cost.	Premiums.	Penalties.
1.	Atlanta	$617,000	.....	....
2.	Baltimore	1,325,000	$106,400	
3.	Bancroft	250,000	45,000	....
4.	Bennington	490,000	3,600	....
5.	Boston	619,000	..	....
6.	Castine	318,000	50,000	....
7.	Charleston	1,017,500	.....	$33,300
8.	Chicago	889,000	.....	....
9.	Columbia	2,725,000	350,000	....
10.	Concord	490,000	450	....
11.	Cushing	82,700	....	....
12.	Detroit	612,500	150,000	....
13.	Dolphin	315,000	.....	....
14.	Machias	318,000	45,000	....
15.	Marblehead	674,000	125,000	....
16.	Monterey	1,628,900	....	32,800
17.	Montgomery	612,500	200,000	....
18.	Newark	1,248,000	36,800	....
19.	New York	2,985,000	200,000	....
20.	Olympia	1,796,000	300,000	
21	Petrel	247,000	....	450
22.	Philadelphia	1,350,000	100,000	....
23.	San Francisco	1,428,000	100,000	....
24.	Vesuvius	350,000	.....	....
25.	Yorktown	455,000	39,800	....
	Total	$22,843,100	$1,852,050	$66,550

Subtracting penalties from premiums, we have

$1,785,500 net premiums given to contractors for speed and horse power.

Cost of 25 ships	$22,843,100
Net premiums	1,785,500
Actual cost	$24,628,600

Now take into consideration the ships being built by contract:

	Contract Price.
1. Brooklyn	$2,986,000
2. Ericsson	113,500
3. Indiana	3,020,000
4. Iowa	3,010,000
5. Katahdin	930,000
6. Massachusetts	3,020,000
7. Minneapolis	2,600,000
8. Oregon	3,180,000
9. Gunboat No. 7	280,000
10. Gunboat No. 8	280,000
11. Gunboat No. 9	280,000
Total	$19,789,500

To this can be safely added $1,000,000 for premiums. This amount is, in reality, very low, for the Minneapolis has just made $402,500 and the Brooklyn will probably make $200,000 in premiums. This will then give a total cost of eleven ships building by contract, $20,789,500, or a total cost of $45,418,100 for thirty-six ships. In addition to the above there are nine ships being built at the various navy yards or now completed:

1. Maine, nearly ready for service, New York.
2. Texas, nearly ready for service, Norfolk.
3. Cincinnati, nearly ready for service, New York.
4. Raleigh, nearly ready for service, Norfolk.
5. Terror, building at New York.
6. Amphitrite, building at Norfolk.
7. Puritan, building at New York.
8. Monadnock, building at San Francisco.
9. Miantonomoh, in commission.

The following table shows the displacement, speed, and horse power of ships now in service:

	Knots. Speed.	Horse Power.	Displacement.
Columbia	22·80	18,000	7,350
Vesuvius	22·50	3,700	930
Olympia	21·68	17,000	5,500
New York	21·07	17,000	8,150
Baltimore	20·00	10,000	4,600
Philadelphia	19·70	8,800	4,325
San Francisco	19·50	8,800	4,080
Montgomery	19·05	5,500	2,000
Newark	19·00	8,800	4,080
Cushing	19·00	1,600	120
Detroit	18·70	5,200	2,000
Marblehead	18·44	5 000	2,000
Charleston	18·30	6,400	3,600
Bennington	17·50	3,350	1,700
Concord	16·80	3,340	1,700
Yorktown	16·10	3,320	1,700
Castine	16 00	2,150	1,050
Boston	15·50	4,000	3,200
Dolphin	15·50	2,200	1,485
Machias	15·50	1,850	1,050
Chicago	15·30	5,000	4,500
Bancroft	15·00	1,200	830
Atlanta	15·00	4,000	3 200
Monterey	13·00	5,000	4,000
Petrel	11·80	1,500	890

It will no doubt be a surprise to most readers to know that the Chicago's speed limit is 15·30 knots, but it should be remembered that she was one of the first ships of this new navy, and that since she was finished, there have been tremendous strides made in the construction of engines.

[THE PRACTICAL ENGINEER.]

WIND MOTORS, ANCIENT AND MODERN.

By SIDNEY H. HOLLANDS.

THE windmill can boast a very respectable antiquity. In the "Spiritalia," of Hiero of Alexandria, 150 B. C., is described a windmill, which worked an air pump for supplying an organ with wind; while this motor is also frequently mentioned in Roman history, as well as in mediæval Continental records.

The windmill was first introduced into England from the Netherlands at the end of the twelfth century, where it was called into use for lifting and removing water from the submerged tracts, swamps, and "meers" of that low-lying watery country, and where it is still a very familiar and salient feature of the flat landscape. It is computed that no less than twelve thousand windmills, averaging eight horse power each, are in operation in Holland, chiefly employed in pumping and draining; for the most part lifting the water a small height by means of "scoop wheels." If we moderns could only reckon on a wind, from any quarter, of a minimum velocity of say ten miles per hour being available every working day of the year, it is probable that steam power for land purposes would be in little request.

The economy due to the employment of the natural physical forces direct from the hand of Nature is scarcely questionable. The tenacity with which the old windmill has held on in favor, and the demand which has created its modern high-speed prototype, despite the intermittent source of its power, and the cheapness of modern steam and gas power, all emphasize this fact.

The general form and arrangement of mechanism in windmills may be described as follows: The sail axle, or shaft, at the top of the mill, carries a large bevel wheel, which gears with a pinion at the top of a vertical shaft, running down centrally through the mill. This shaft carries also a large spur wheel—near its lower end, under the first floor—which gears with pinions on the millstone spindles, generally two in number. Other pinions gear with this wheel also, or with another one higher up on the same shaft, which drive respectively the bolting or flour-dressing machine, smut-cleaning machine, winnowing fan, and sack hoist—the latter being driven through a friction gear, thrown in and out by hand as required. Mortise gearing is used throughout, where, indeed, the wheels and the shafts are not wholly of wood, as they are still to be found in the old mills. The spindles carrying and driving the millstones, and on the top of which the running stones are balanced, are carried in footstep bearings, mounted on a beam or lever, pivoted at one end. A lifting screw supports the other end of this lever, and has a nut-boss handwheel, or a large wing nut bearing on a fixed abutment, for raising or lowering the stone, altering the space between it and the stationary bedstone, so grinding the mill coarser or finer, as desired. The stones, which are usually four feet diameter, and weigh nearly one ton each, are run at about 140 revolutions per minute. Each pair takes about five brake-horse power. For two pairs of stones, together with the dressing and other machinery, about twelve brake horse power is required, which is about the power of an average English windmill.

In the earliest windmills, the means adopted for presenting the sails to face the wind was to have the mill afloat, and turn it bodily in the water, as required. It was next mounted on a pivot post, and turned bodily on this by hand. This is known as the German method, and is still used in the south of England. After this the mill was built with a stationary body, in shape, generally, a frustum of a cone, either circular or polygonal in plan, somewhat of lighthouse form, and surmounted by a rotating cap, which carried with it the sails and their shaft, having bearings within the cap—a Dutch invention of the sixteenth century. This cap was at first slewed round by hand, as required, and it was not until early in the present century that the automatic turning mechanism, now so generally used, was invented and applied.

The automatic reefing and feathering gear for sails was not introduced until the year 1772. This admirable invention is also now used in nearly all windmills. These two automatic gears relieved the miller of much anxious vigilance and work, and almost made the mill look after itself. The general form of the four-armed sails is familiar to all, but it may not be amiss to describe in detail the ancient and modern forms of both. The old Dutch mill, as first imported, had its sails formed simply of canvas, stretched on rough, ladder-like frames, fastened to the four "whips," or sail arms, which, in turn, were fastened to a cruciform structure forming the hub, or nave. These sails were made very wide at the tips, and were "dished" considerably. It was soon found necessary to provide means of reefing the sails in heavy winds, and when the mill was not in use. Accordingly, the canvas was permanently fastened to the leading edge of the sails only, and provision was made for reefing them wholly or partly, the canvas being gathered into folds on the fastened side by suitable halliards and reef points; the area being thereby reduced much in the same way as a ship's sails are reefed and clewed up to the spars. By and by this primitive method was found to be cumbrous and inconvenient, occupying much time, too.

In 1804, Bywater, of Nottingham, patented a method of reefing the sails by winding the fabric on to a long roller mounted in bearings on the whip, and which was actuated by suitably arranged cords led to the axle. This was a great improvement on the foregoing method, and found much favor. After this the comparatively modern and now generally prevailing English type of automatic reefing sails was evolved, the old canvas sails being now almost extinct. In this new type of reefing gear, in place of canvas, the sail frames are fitted with a series of transverse wooden slats, arranged like the laths of a Venetian blind, but pivoted on one edge, and having their bearings in the sides of the sail frame. They are arranged to form a continuous surface when shut. All the slats in each sail are so coupled to one long rod, running radially from the center, as to be either opened or closed by a single push or pull of the rod, and, conversely, the slats giving a continuous pull on this rod as long as there is wind pressure on them. The inner end of each of the four rods is coupled to one arm of a bell crank lever, the four bell cranks being pivoted on fixed standards bolted to the sail arms near the axle. The other (and inner) arms of the bell cranks are coupled by links to the four arms of a central crosshead, fastened to the end of a central rod passing through the sail shaft, which is made hollow. At the rear end of the rod is an eye, to which a cord or chain is attached, running over a sheave, and having a weight suspended from its other end. It will thus be seen that a wind blowing on the face of the sails will tend to open the slats against the resistance of this weight, which will be so adjusted as to keep them closed against moderate winds, but to admit of their turning nearly wide open, and presenting little more than edge resistance to a gale or storm. With abating wind pressure the slats will automatically commence closing, and so meeting lessening pressure with increasing effective area of sails. This admirable mechanism is, therefore, at once an automatic speed governor and a safety appliance against damage to the sails or mill by violent winds.

A former method of automatic speed governing (now practically obsolete) was by means of the centrifugal ball governor, which was coupled through a system of compound levers to the millstone spindles, and so arranged that with a slackening of the wind and consequent decrease of speed of sails, the governor would slightly lift the running stone from its bed, thus lessening the resistance to rotation. This was so adjusted as to keep the speed as nearly constant as possible; but, although it answered that purpose to some extent, it was objectionable, and apparently illogical, too, in that it caused the meal to be ground coarse or fine, according as the wind was light or heavy, and in a high wind would so lower the stones almost or quite into contact as to cause a very heavy and trying drag on the gearing and sails, even occasionally firing the bearings when these were not well lubricated and properly adjusted (which was a frequent condition), and so burning the mill down. Touching the use of the ball governor, it is an interesting and significant fact that this was used in windmills long before its application to steam engines, James Watt having seen it in mills, and took it thence to apply to his steam engine. He is generally credited with having invented this governor.

The next important advance was the automatic mechanism, before alluded to, designed to keep the sails facing the wind, however it might shift round. This was, and still is, attained by a fan (generally six-vaned) carried on bearing brackets springing from the back of the cap, and rotating on a horizontal spindle at right angles to the sail axis. The fan spindle carries a bevel pinion, gearing with a bevel wheel on an inclined shaft, actuating either a bevel and worm or a bevel and spur gear at the lower edge of the cap.

The worm or spur pinion, as the case may be, gears with a fixed circular rack, fastened around the top of the stationary mill body. The action of this gear is such, that as long as the wind is blowing directly on to the face of the sails, and consequently in a plane parallel to the fan's disk, the fan remains stationary, but if the wind veers round ever so little, the fan will begin to rotate, and through the train of gearing, will slew the cap of the mill round, and with it the sails bodily, until they face squarely to the wind again, when the fan stops.

It is surprising how closely to the wind these fans will start and continue to act. They are, of course, made to run with very little friction, and have a high ratio of gearing. The slewing around of the cap does not affect the main gearing within the mill, in that the bevel wheel on the sail shaft is thereby merely shifted round the periphery of its pinion on the vertical main shaft as a center.

In some cases this fan has been mounted on a carriage, running on a circular path on the ground around the mill base, and attached to a pole projecting from the mill, which turns on a post. The fan is geared to the wheels of this carriage, which rather resembles a very cumbrous bicycle, with the mounted fan driving it, in place of a man, and which, as it travels slowly round—with a change of wind—by the bite of its wheels on the ground, pulls the mill round with it. Several mills having this appliance may be seen in the southwest of Sussex.

The sail axle of windmills is not mounted horizontally, but is inclined at from 8° to 15° with the horizon; the latter angle on hills and exposed positions, and the former on plains or level ground. The reason of this is, that the wind has been found to blow with a generally downward inclination, which is more pronounced on high, exposed positions. The diameter of the disk swept by the sails is usually about 70 ft., and the virtual pitch, regarding the sails as a four-bladed screw, is about 37 ft. With a 15 mile breeze and full load, the sails make about 13 revolutions per minute. They are made with a twist in them, the tips being at an angle of only 5° with the plane of motion, while at the roots it reaches 22½°. When so formed they have been found to give a high efficiency, and the speed of rotation at the tips will then equal 2·6 times the velocity of the wind driving them. The "whip," or backbone, of each sail is a piece of timber, usually 30 ft. long, 12 in. wide, and 9 in. deep at the inner end, and tapering to 6 in. by 4½ in. at the tips, sometimes bolted to a four-armed center casting. The sails start at about 4 ft. from the axis, and have each a mean breadth of 8 ft., being widest at the tips. The writer remembers a windmill with six sails, which mill stood on the South Downs, near Lewes, in his youth. This was locally considered to be quite a curiosity, and certainly struck the observer as odd looking. It would be interesting to know what gain was found with this form, i. e., how much under 50 per cent. in excess of four-sail mills of equal diameter or disk area.

The horse power of windmills may be calculated as follows:

$$\frac{A\ V^3}{1080000} = \text{H. P. (gross)},$$

where A = total area of sails in square feet and V = velocity of wind in feet per second.

The American type, or annular sail wind motor, which prevails all over Canada and the United States, is now being rather largely introduced into England and the colonies. In this type, of which there are no less than twelve varieties, comprising a display of great ingenuity in the scheming of their gear, the sail surface is an annulus or broad ring, formed of radial slats. Each slat, of which there are perhaps fifty, is a small sail in itself, and is, in most cases, set in its frame at a fixed angle to the plane of motion, the effective wind pressure being automatically varied by making the wind wheel slew out of, or away from, the wind, so that its disk becomes more and more oblique to the direction of the wind as the pressure increases, thus foreshortening the wheel to the wind. This form has a single vane or rudder parallel to the sail disk, and carried on an arm springing from one side of the gear frame. This rudder acts against the resistance of a weighted lever, which slews the wheel back into the wind again when the pressure subsides to the normal. This variety is called in the States the "solid wind wheel," to distinguish it from those forms which have sail-reefing mechanism. Of the latter, one form in particular, which seems to meet with most favor, merits description, if only on account of its curious and original reefing mechanism.

In the type referred to the annulus is made up of six, eight, or more segmental frames, each carrying a number of fixed vanes and pivoted on axes which are tangential to a circle described on the wheel face. This wheel is reefed, both automatically and by hand, by causing the sail frames to turn on their axes, so that, when fully reefed, the frames assume a position parallel to the main axle, and are then quite ineffective, the mill being thereby stopped. Intermediate positions, of course, place the vane frames more or less obliquely to the wind by means of a large rudder in the wake of it. In some cases the reefing gear is actuated by a centrifugal governor; the arrangement is analogous in action to an engine cut-off gear. This mill, when seen at rest with the sails fully reefed, presents a very wreckish, dilapidated, and generally startling appearance. It is strongly suggestive of a large umbrella which has had its ribs unshipped and has otherwise come to grief in a gale of wind. These annular sails certainly make a much neater form of wind motor than the old four-sweep sails, and will probably quite supersede them eventually. They are much smaller and lighter for a given power with the same wind, running at higher speeds than the old type. They range in size from 8 ft. 6 in. in diameter to about 50 ft.

Mr. Alfred R. Wolff, of New York, perhaps the best living authority on annular windmills, roughly computed that in 1885 there were several hundreds of thousands of these in use in the United States. The

diminished only to singularly increase that of the minor ones. Experience, nevertheless, seems to pronounce rather in favor of the ascending method, which is applied with large chambers of feeble height at the Grand'Maison and with small chambers previously surrounded by a system of galleries at the Foret.

Fig. 2 shows how the operation is performed at the Foret, in excavating successively, starting from the bottom and for the entire width of the chamber, a series of trenches 12 feet in depth. Above, upon a platform suspended from the slate roof by iron rods, men are seen boring blast holes. Beneath them may be seen the front of the 12 foot cutting, which gradually recedes in measure as the work goes on. Lower still, a dark band represents the upper part of the space created by the exploitation of the lower section already removed, the rest of the space having been filled in with material that forms the floor, and upon this material there rests to the right a large block of slate that, after being divided into sufficiently small pieces, is to be carried away upon a small platform car moving upon rails. Here, again, the lighting is done by electricity, through incandescent lamps suspended by a cord and that are lifted to the ceiling by pulleys before a blast is fired.

After the blocks of slate have been extracted by any of these methods and raised to the surface, it remains to shape them.

The working of the slate for roofing must be done in situ before the material has dried, and, in losing its water, has lost also its fissility. The block is first slit into thick plates by means of a chisel. Then the slitter, seated under a wind screen, his feet incased in thick sabots and his legs wrapped with rags to prevent him from wounding himself, places the fragment of schist between his legs, and, provided with a very thin chisel and a mallet, strikes the edge in order to detach sheets from it. All that has to be done then is to give this sheet its proper form and size. This is done by means of a plane iron—a very heavy iron knife, whose extremity is shored into a ring and which turns down against the edge of a block.

The laborers are so used to this work that they perform it very rapidly, and at the rate of from 700 to 800 slates per day. But the more the dimensions of the slate are increased (as is now the tendency in order to compete with machine-made tiles), the more delicate the operation becomes; and this question of large sized slates, called the "large English," is a source of frequent conflicts between bosses and workmen. It is estimated that an outside laborer earns from fifty-five to seventy cents a day, and a pitman from sixty to eighty cents.

There might be still much to say about the curious working costumes that have been perpetuated at Angers from the middle ages up to recent years, and are but slowly disappearing one by one; but this is a subject that we do not wish to touch upon here, and we shall content ourselves with a few statistical figures for finishing this curious study.

In 1893, the slate quarries of Maine-et-Loire gave employment to 1,034 inside and 2,185 outside laborers—say altogether 3,219, of whom 1,511 were slitters. In 1891 a total of 2,749 was divided into 2,121 for the center of Angers (Trelazé), 109 for the Foret and 135 for Misengrain. During the year these 2,749 laborers produced 159,820,047 slates, worth $710,650.

The figures of 1893 correspond to a certain revival in this industry, which for some years previous had undergone a crisis due especially to the competition of machine-made tiles. As a sequel to the reduction in the production, it has been possible to raise the price slightly.—La Nature.

GRADUATE AND POST-GRADUATE ENGINEERING DEGREES.*

By Prof. GEO. F. SWAIN, Mass. Inst. Technology, Boston.

BEFORE considering the engineering degrees, it is desirable to understand clearly that such a degree simply represents that the holder has passed successfully through a certain prescribed academic course. A diploma is a certificate of work done—nothing more. It is neither a certificate of character, a guarantee of ability to enter at once upon responsible work, nor a recommendation; for any school is likely to award its diploma to men who, while they may have completed the prescribed course, are not such men that the members of the faculty might individually be willing to recommend them. Of course, if a school requires a high standard of scholarship and morals, and if the daily work of the students is rigidly scrutinized, a four years' course will generally result in weeding out the poor men, so that the diploma of such a school will be looked upon as a recommendation of the person holding it. This, however, is an inference from the degree, and not a characteristic of the degree itself.

If, then, a diploma simply represents a certain amount of academic work done, it seems desirable that the form of degree should clearly indicate this fact, and should not be a degree that is liable to be confused with the simple name of a profession or occupation.

Engineering degrees are of three kinds. First, we have the degrees bachelor of science or of philosophy (S.B. or Ph.B.) for undergraduate degrees, and the post-graduate degrees master or doctor of science or of philosophy (M.S., S.D., or Ph.D.) These all correspond to the established classical degrees which have come down to us from the middle ages or from earlier times—bachelor of arts or "artium baccalaureus" (A.B.); master of arts, "artium magister" (A.M.); doctor of medicine, "medicinae doctor" (M.D.), and so on. These degrees have no meaning except as academic degrees, and they are recognized at once as such.

Second come the so-called descriptive degrees, which are simply names of the professions for which the holders are supposed to be fitted, such as "civil engineer" (C.E.), "mechanical engineer" (M.E.), "electrical engineer" (E.E.), and others.

These descriptive degrees appear much less suitable than degrees of the first class, for the following reasons. In the first place, they are not in line with the old established classical degrees, and it is desirable that all degrees should be on some uniform basis. It is inconsistent for a university to give the degree A.B. ("artium baccalaureus") in its classical course and C.E. in its engineering course. In the second place, the multiplication of descriptive degrees leads to confusion. Shall the degree for a course in chemistry be simply "chemist" (C.), and in achitecture "architect" (A.)? It would be just as reasonable to give different degrees in medicine, and to give to John Smith the degree E.D. (eye doctor), or to Thomas Jones the degree L.D. (lung doctor). In the third place, the degrees like C.E. are liable to abuse, and many practitioners write these letters after their names, either for convenience as an abbreviation simply or with intent to deceive. There is no temptation to wrongfully appropriate the degree S.B. In the fourth place, no academic course can make a man an engineer, so that the degrees C.E. and others like it involve a contradiction in terms. All engineering courses are principally courses in science—in the scientific principles underlying the engineering professions; and the degree in science appears in all respects the most suitable. Thus the graduate in civil engineering would be bachelor of science in the department of civil engineering. Another class of degrees includes those like bachelor of civil engineering (B.C.E.) These degrees obviate many of the objections to the simple C.E. degree, but appear less suitable than the simple science degrees, and they involve confusion and a multiplicity of titles, if applied to all the technical professions.

In some schools the baccalaureate degree is S.B. or Ph.B., while C.E. is given after a certain amount of practical experience. This last degree is, therefore, really an honorary degree, as it is not based on academic work done at the institution. The writer believes that we should be much better off with no honorary degrees whatever, that all degrees should represent actual work done at the school or under its direction, and that the honorary degrees are liable to much abuse, because indiscriminately awarded.

The author concludes that there is no consistent or reasonable ground for the descriptive degrees, and that the proper engineering degrees should be bachelor of science and doctor (or master) of science, or doctor of philosophy.

* Abstract of a paper read before the American Association, Brooklyn, 1894.

GRADUATE AND POST-GRADUATE DEGREES.*

By Dr. R. H. THURSTON, Director of Sibley College, Cornell University.

THE author thought the form of degree to depend, in fact, upon the nature of the course, the logical relations of title to course and to vocation, and to the question of expediency. He refers to three classes of so called technical and engineering schools—those in which some applied science is taught with much of pure science and of literature; those in which a professional course is aimed at, but which, nevertheless, are compelled to do some educational work in literature and in science; those in which, as in law schools, preparatory professional work only is performed. The last only he calls real professional schools—the ideal type at which all aim, but to which few, if any, attain.

In the first two, the work is mixed, partly "educational," partly "professional." In the latter it is assumed that the student is educated as well as his means and his time may permit before coming to the professional school. The author thinks the degree itself to have little intrinsic importance, that the course is the main thing, but that the older form, as B.S., may well suit the first case, the professional form, as C.E. or M.E. the third type of school, and the intermediate schools may be in doubt. He has observed that the men receiving degrees prefer the professional form; but the whole matter assumes less and less importance with him, as he finds, on entrance into professional life, that no one asks to see his diploma, or inquires about its particular form.

* Abstract from remarks made before the American Association, Brooklyn, N. Y., 1894.

ABSTRACT of a paper on Graduate and Post-Graduate Engineering Degrees, by Professor Palmer C. Ricketts, Rensselaer Polytechnic Institute:

A degree conferred at the conclusion of a prescribed course of study merely signifies that the course has been finished to the satisfaction of the corporation conferring it. Therefore, it seems appropriate to use that succession of words for the degree or that succession of letters for its abbreviation which most nearly indicates the character and object of the curriculum. Since engineering schools generally confer the degrees C.E. and M.E., there seems to be no reason to change.

The course, and not the degree, counts, and after a professional man has had some experience and become a member of a recognized engineering society, he very seldom uses the degree obtained from the school, but uses the abbreviations of the professional society.

[NAUTICAL MAGAZINE.]

GREAT CIRCLE SAILING.

UP to the present time, the practical solution of the problem of great circle sailing has not been required for even the extra certificate at the Board of Trade. In view, therefore, of its introduction into the proposed examinations in Captain Beall's new syllabus, and from the prominent place the subject has occupied in the navigation papers of the Science and Art examinations of this year, I may not be out of season in submitting a method of finding the great circle distance which requires fewer figures than the methods given in Raper and Norie, but it is to be found in the last edition of Merrifield's "Treatise on Navigation." Beginning with the investigation of the rule:

Let d = the great circle distance.
" p = the difference of longitude between the two places.
" λ = the greater colat.
" l = the lesser colat.

Then,

$$\text{Cos } d = \cos \lambda \cos l + \sin \lambda \sin l \cos p \quad \ldots\ldots (1)$$

Assume that

$$\text{Cos } l = k \cos N \quad \ldots\ldots (2)$$

$$\text{Sin } l \cos p = k \sin N \quad \ldots\ldots (3)$$

Satisfy the conditions of equation (1)

Eliminate k by dividing equation (3) by equation (2) and we get:

$$\text{Tan } N = \tan l \cos p \quad \ldots\ldots (4)$$

From equation (2) we get:

$$k = \cos l \sec N.$$

Substituting in equation (1) the values in (2) and (3), we get:

$$\text{Cos } d = k (\cos \lambda \cos N + \sin \lambda \sin N).$$
$$= k \cos (\lambda - N).$$

Therefore,

$$\text{Cos } d = \cos l \sec N \cos (\lambda - N).$$

Or,

$$\text{Cos } d = \cos l \sec N \cos (\lambda \pm N) \quad \ldots\ldots (5)$$

The double sign in the expression $(\lambda \pm N)$ signifies that when the difference of longitude between the two places exceeds 90°, the auxiliary angle or arc N is to be added to the colatitude λ, but if the difference of longitude is less than 90°, N is to be subtracted from the colatitude λ.

The courses may be readily obtained by the ratio existing between the sines of the sides and the sines of the angles in a spherical triangle.

If we designate the course by C we have:

$$\text{Sin } C = \sin l \sin p \operatorname{cosec} d,$$

which gives the course from the place of greater colatitude to the place of lesser colatitude reckoned from the same pole,

$$\text{Sin } C' = \sin \lambda \sin p \operatorname{cosec} d,$$

gives the course from the place of lesser colatitude.

We may now put equations (4) and (5) into a form for calculating by logarithms and introduce a numerical example.

Find the great circle distance from Swan River, lat. 32° 3' S., long. 115° 45' E., to the Cape of Good Hope, lat. 34° 0' S., long. 18° 30' E.:

	C. G. Hope.		Swan River.	Long.	
Lat.	34° 0' S.	Lat.	32° 3' S.	115° 45'	S. River.
Colat.	56° 0'	Colat.	57° 57'	18° 30'	C. G. H.
				Diff. long. 97° 15'	
Colat. l		= 56° 0'	tan 0·17101		cos 9·74756
Diff. long. p		= 97° 15'	cos 9·10106		
Arc N		= 10° 36'	tan 9·27307		sec 0·00747
Colat. λ		= 57° 57'			
(λ + N)		= 68° 33'			cos 9·56311
		d = 78° 0'			cos 9·31814
		60			
Great circle distance		= 4680 miles.			

If the sum or difference of the auxiliary arc N and the greater colatitude exceed 90°, take the supplement of d found for the cosine and reduce it to minutes of arc for the distance.

Example.—From East Cape, New Zealand, lat. 37° 40' S., long. 178° 36' E., to San Francisco, lat. 37° 48' N., long. 122° 24' W. Find the great circle distance.

Taking the North Pole for the colats.

East Cape, lat.	37° 40' S.	San F. lat.	37° 48' N.	Long.	
	90°		90°	178° 36'	E.
Greater colat.	127° 40'	Lesser colat.	52° 12'	122° 24'	W.
				301° 0'	
				360°	
				Diff. long. 59° 0'	
Colat.	32° 12'	tan 0·11082		cos 9·78739	
Diff. long.	59° 0'	cos 9·71184			
N =	33° 35'	tan 9·82216		sec 0·07931	
Colat.	127° 40'				
Diff. =	94° 5'			cos 8·85252	
d =	87° 0'			cos 8·71922	
	180°				
	93° 0'				

Great circle dist. = 5580 miles.

The geometrical meaning of the auxiliaries k and N is, k is the cosine of the perpendicular let fall from the place of lesser colatitude upon the meridian of the place of greater colatitude, and N is the arc intercepted between the pole and the perpendicular of which k is the cosine, which may be readily verified by the construction of a freehand figure.

T. MACKENZIE, F.R.A.S.

THE COST OF THE NEW NAVY.

WHEN the vessels which are now in process of construction are completed, the new navy of the United States will consist of forty-five vessels ranging in size from the great battle ship Iowa of 11,300 tons down to the torpedo boat Ericsson of 120 tons displacement. For the following particulars in regard to the cost of the vessels, their speed premiums, etc., we are indebted to the New York Times:

		Cost.	Premiums.	Penalties.
1.	Atlanta	$617,000	.....	....
2.	Baltimore	1,325,000	$106,400	....
3.	Bancroft	250,000	45,000	....
4.	Bennington	490,000	3,600	....
5.	Boston	619,000	....	....
6.	Castine	318,000	50,000	....
7.	Charleston	1,017,500	.....	$33,300
8.	Chicago	889,000	.....	....
9.	Columbia	2,725,000	350,000	....
10.	Concord	490,000	450	....
11.	Cushing	82,700	....	....
12.	Detroit	612,500	150,000	....
13.	Dolphin	315,000	.....	....
14.	Machias	318,000	45,000	....
15.	Marblehead	674,000	125,000	....
16.	Monterey	1,628,900	.....	32,800
17.	Montgomery	612,500	200,000	....
18.	Newark	1,248,000	36,800	....
19.	New York	2,985,000	200,000	....
20.	Olympia	1,796,000	300,000	....
21.	Petrel	247,000	.....	450
22.	Philadelphia	1,350,000	100,000	....
23.	San Francisco	1,428,000	100,000	....
24.	Vesuvius	350,000	.....	....
25.	Yorktown	455,000	39,800	....
	Total	$22,843,100	$1,852,050	$66,550

Subtracting penalties from premiums, we have

$1,785,500 net premiums given to contractors for speed and horse power.

Cost of 25 ships	$22,843,100
Net premiums	1,785,500
Actual cost	$24,628,600

Now take into consideration the ships being built by contract:

	Contract Price.
1. Brooklyn	$2,986,000
2. Ericsson	113,500
3. Indiana	3,020,000
4. Iowa	3,010,000
5. Katahdin	930,000
6. Massachusetts	3,020,000
7. Minneapolis	2,690,000
8. Oregon	3,180,000
9. Gunboat No. 7	280,000
10. Gunboat No. 8	280,000
11. Gunboat No. 9	280,000
Total	$19,789,500

To this can be safely added $1,000,000 for premiums. This amount is, in reality, very low, for the Minneapolis has just made $402,500 and the Brooklyn will probably make $200,000 in premiums. This will then give a total cost of eleven ships building by contract, $20,789,500, or a total cost of $45,418,100 for thirty-six ships. In addition to the above there are nine ships being built at the various navy yards or now completed:

1. Maine, nearly ready for service, New York.
2. Texas, nearly ready for service, Norfolk.
3. Cincinnati, nearly ready for service, New York.
4. Raleigh, nearly ready for service, Norfolk.
5. Terror, building at New York.
6. Amphitrite, building at Norfolk.
7. Puritan, building at New York.
8. Monadnock, building at San Francisco.
9. Miantonomoh, in commission.

The following table shows the displacement, speed, and horse power of ships now in service:

	Knots. Speed.	Horse Power.	Displacement.
Columbia	22·80	18,000	7,350
Vesuvius	22·50	3,700	930
Olympia	21·68	17,000	5,500
New York	21·07	17,000	8,150
Baltimore	20·00	10,000	4,600
Philadelphia	19·70	8,800	4,325
San Francisco	19·50	8,800	4,080
Montgomery	19·05	5,500	2,000
Newark	19·00	8,800	4,080
Cushing	19·00	1,600	120
Detroit	18·70	5,200	2,000
Marblehead	18·44	5,000	2,000
Charleston	18·20	6,400	3,600
Bennington	17·50	3,350	1,700
Concord	16·80	3,340	1,700
Yorktown	16·10	3,320	1,700
Castine	16·00	2,150	1,050
Boston	15·50	4,000	3,200
Dolphin	15·50	2,200	1,485
Machias	15·50	1,850	1,050
Chicago	15·30	5,000	4,500
Bancroft	15·00	1,200	830
Atlanta	15·00	4,000	3,200
Monterey	13·60	5,000	4,000
Petrel	11·80	1,500	890

It will no doubt be a surprise to most readers to know that the Chicago's speed limit is 15·30 knots, but it should be remembered that she was one of the first ships of this new navy, and that since she was finished, there have been tremendous strides made in the construction of engines.

[THE PRACTICAL ENGINEER.]

WIND MOTORS, ANCIENT AND MODERN.

By SIDNEY H. HOLLANDS.

THE windmill can boast a very respectable antiquity. In the "Spiritalia," of Hiero of Alexandria, 150 B. C., is described a windmill, which worked an air pump for supplying an organ with wind; while this motor is also frequently mentioned in Roman history, as well as in mediæval Continental records.

The windmill was first introduced into England from the Netherlands at the end of the twelfth century, where it was called into use for lifting and removing water from the submerged tracts, swamps, and "meers" of that low-lying watery country, and where it is still a very familiar and salient feature of the flat landscape. It is computed that no less than twelve thousand windmills, averaging eight horse power each, are in operation in Holland, chiefly employed in pumping and draining; for the most part lifting the water a small height by means of "scoop wheels." If we moderns could only reckon on a wind, from any quarter, of a minimum velocity of say ten miles per hour being available every working day of the year, it is probable that steam power for land purposes would be in little request.

The economy due to the employment of the natural physical forces direct from the hand of Nature is scarcely questionable. The tenacity with which the old windmill has held on in favor, and the demand which has created its modern high-speed prototype, despite the intermittent source of its power, and the cheapness of modern steam and gas power, all emphasize this fact.

The general form and arrangement of mechanism in windmills may be described as follows: The sail axle, or shaft, at the top of the mill, carries a large bevel wheel, which gears with a pinion at the top of a vertical shaft, running down centrally through the mill. This shaft carries also a large spur wheel—near its lower end, under the first floor—which gears with pinions on the millstone spindles, generally two in number. Other pinions gear with this wheel also, or with another one higher up on the same shaft, which drive respectively the bolting or flour-dressing machine, smut-cleaning machine, winnowing fan, and sack hoist—the latter being driven through a friction gear, thrown in and out by hand as required. Mortise gearing is used throughout, where, indeed, the wheels and the shafts are not wholly of wood, as they are still to be found in the old mills. The spindles carrying and driving the millstones, and on the top of which the running stones are balanced, are carried in footstep bearings, mounted on a beam or lever, pivoted at one end. A lifting screw supports the other end of this lever, and has a nut-boss handwheel, or a large wing nut bearing on a fixed abutment, for raising or lowering the stone, altering the space between it and the stationary bedstone, so grinding the mill coarser or finer, as desired. The stones, which are usually four feet diameter, and weigh nearly one ton each, are run at about 140 revolutions per minute. Each pair takes about five brake-horse power. For two pairs of stones, together with the dressing and other machinery, about twelve brake horse power is required, which is about the power of an average English windmill.

In the earliest windmills, the means adopted for presenting the sails to face the wind was to have the mill afloat, and turn it bodily in the water, as required. It was next mounted on a pivot post, and turned bodily on this by hand. This is known as the German method, and is still used in the south of England. After this the mill was built with a stationary body, in shape, generally, a frustum of a cone, either circular or polygonal in plan, somewhat of lighthouse form, and surmounted by a rotating cap, which carried with it the sails and their shaft, having bearings within the cap—a Dutch invention of the sixteenth century. This cap was at first slewed round by hand, as required, and it was not until early in the present century that the automatic turning mechanism, now so generally used, was invented and applied.

The automatic reefing and feathering gear for sails was not introduced until the year 1772. This admirable invention is also now used in nearly all windmills. These two automatic gears relieved the miller of much anxious vigilance and work, and almost made the mill look after itself. The general form of the four-armed sails is familiar to all, but it may not be amiss to describe in detail the ancient and modern forms of both. The old Dutch mill, as first imported, had its sails formed simply of canvas, stretched on rough, ladder-like frames, fastened to the four "whips," or sail arms, which, in turn, were fastened to a cruciform structure forming the hub, or nave. These sails were made very wide at the tips, and were "dished" considerably. It was soon found necessary to provide means of reefing the sails in heavy winds, and when the mill was not in use. Accordingly, the canvas was permanently fastened to the leading edge of the sails only, and provision was made for reefing them wholly or partly, the canvas being gathered into folds on the fastened side by suitable halliards and reef points; the area being thereby reduced much in the same way as a ship's sails are reefed and clewed up to the spars. By and by this primitive method was found to be cumbrous and inconvenient, occupying much time, too.

In 1804, Bywater, of Nottingham, patented a method of reefing the sails by winding the fabric on to a long roller mounted in bearings on the whip, and which was actuated by suitably arranged cords led to the axle. This was a great improvement on the foregoing method, and found much favor. After this the comparatively modern and now generally prevailing English type of automatic reefing sails was evolved, the old canvas sails being now almost extinct. In this new type of reefing gear, in place of canvas, the sail frames are fitted with a series of transverse wooden slats, arranged like the laths of a Venetian blind, but pivoted on one edge, and having their bearings in the sides of the sail frame. They are arranged to form a continuous surface when shut. All the slats in each sail are so coupled to one long rod, running radially from the center, as to be either opened or closed by a single push or pull of the rod, and, conversely, the slats giving a continuous pull on this rod as long as there is wind pressure on them. The inner end of each of the four rods is coupled to one arm of a bell crank lever, the four bell cranks being pivoted on fixed standards bolted to the sail arms near the axle. The other (and inner) arms of the bell cranks are coupled by links to the four arms of a central crosshead, fastened to the end of a central rod passing through the sail shaft, which is made hollow. At the rear end of the rod is an eye, to which a cord or chain is attached, running over a sheave, and having a weight suspended from its other end. It will thus be seen that a wind blowing on the face of the sails will tend to open the slats against the resistance of this weight, which will be so adjusted as to keep them closed against moderate winds, but to admit of their turning nearly wide open, and presenting little more than edge resistance to a gale or storm. With abating wind pressure the slats will automatically commence closing, and so meeting lessening pressure with increasing effective area of sails. This admirable mechanism is, therefore, at once an automatic speed governor and a safety appliance against damage to the sails or mill by violent winds.

A former method of automatic speed governing (now practically obsolete) was by means of the centrifugal ball governor, which was coupled through a system of compound levers to the millstone spindles, and so arranged that with a slackening of the wind and consequent decrease of speed of sails, the governor would slightly lift the running stone from its bed, thus lessening the resistance to rotation. This was so adjusted as to keep the speed as nearly constant as possible; but, although it answered that purpose to some extent, it was objectionable, and apparently illogical, too, in that it caused the meal to be ground coarse or fine, according as the wind was light or heavy, and in a high wind would so lower the stones almost or quite into contact as to cause a very heavy and trying drag on the gearing and sails, even occasionally firing the bearings when these were not well lubricated and properly adjusted (which was a frequent condition), and so burning the mill down. Touching the use of the ball governor, it is an interesting and significant fact that this was used in windmills long before its application to steam engines, James Watt having seen it in mills, and took it thence to apply to his steam engine. He is generally credited with having invented this governor.

The next important advance was the automatic mechanism, before alluded to, designed to keep the sails facing the wind, however it might shift round. This was, and still is, attained by a fan (generally six-vaned) carried on bearing brackets springing from the back of the cap, and rotating on a horizontal spindle at right angles to the sail axis. The fan spindle carries a bevel pinion, gearing with a bevel wheel on an inclined shaft, actuating either a bevel and worm or a bevel and spur gear at the lower edge of the cap.

The worm or spur pinion, as the case may be, gears with a fixed circular rack, fastened around the top of the stationary mill body. The action of this gear is such, that as long as the wind is blowing directly on to the face of the sails, and consequently in a plane parallel to the fan's disk, the fan remains stationary, but if the wind veers round ever so little, the fan will begin to rotate, and through the train of gearing, will slew the cap of the mill round, and with it the sails bodily, until they face squarely to the wind again, when the fan stops.

It is surprising how closely to the wind these fans will start and continue to act. They are, of course, made to run with very little friction, and have a high ratio of gearing. The slewing around of the cap does not affect the main gearing within the mill, in that the bevel wheel on the sail shaft is thereby merely shifted round the periphery of its pinion on the vertical main shaft as a center.

In some cases this fan has been mounted on a carriage, running on a circular path on the ground around the mill base, and attached to a pole projecting from the mill, which turns on a post. The fan is geared to the wheels of this carriage, which rather resembles a very cumbrous bicycle, with the mounted fan driving it, in place of a man, and which, as it travels slowly round—with a change of wind—by the bite of its wheels on the ground, pulls the mill round with it. Several mills having this appliance may be seen in the southwest of Sussex.

The sail axle of windmills is not mounted horizontally, but is inclined at from 8° to 15° with the horizon; the latter angle on hills and exposed positions, and the former on plains or level ground. The reason of this is, that the wind has been found to blow with a generally downward inclination, which is more pronounced on high, exposed positions. The diameter of the disk swept by the sails is usually about 70 ft., and the virtual pitch, regarding the sails as a four-bladed screw, is about 37 ft. With a 15 mile breeze and full load, the sails make about 13 revolutions per minute. They are made with a twist in them, the tips being at an angle of only 5° with the plane of motion, while at the roots it reaches 22½°. When so formed they have been found to give a high efficiency, and the speed of rotation at the tips will then equal 2·6 times the velocity of the wind driving them. The "whip," or backbone, of each sail is a piece of timber, usually 30 ft. long, 12 in. wide, and 9 in. deep at the inner end, and tapering to 6 in. by 4½ in. at the tips, sometimes bolted to a four-armed center casting. The sails start at about 4 ft. from the axis, and have each a mean breadth of 8 ft., being widest at the tips. The writer remembers a windmill with six sails, which mill stood on the South Downs, near Lewes, in his youth. This was locally considered to be quite a curiosity, and certainly struck the observer as odd looking. It would be interesting to know what gain was found with this form, i. e., how much under 50 per cent. in excess of four-sail mills of equal diameter or disk area.

The horse power of windmills may be calculated as follows:

$$\frac{A\ V^3}{1080000} = \text{H. P. (gross)},$$

where A = total area of sails in square feet and V = velocity of wind in feet per second.

The American type, or annular sail wind motor, which prevails all over Canada and the United States, is now being rather largely introduced into England and the colonies. In this type, of which there are no less than twelve varieties, comprising a display of great ingenuity in the scheming of their gear, the sail surface is an annulus or broad ring, formed of radial slats. Each slat, of which there are perhaps fifty, is a small sail in itself, and is, in most cases, set in its frame at a fixed angle to the plane of motion, the effective wind pressure being automatically varied by making the wind wheel slew out of, or away from, the wind, so that its disk becomes more and more oblique to the direction of the wind as the pressure increases, thus foreshortening the wheel to the wind. This form has a single vane or rudder parallel to the sail disk, and carried on an arm springing from one side of the gear frame. This rudder acts against the resistance of a weighted lever, which slews the wheel back into the wind again when the pressure subsides to the normal. This variety is called in the States the "solid wind wheel," to distinguish it from those forms which have sail-reefing mechanism. Of the latter, one form in particular, which seems to meet with most favor, merits description, if only on account of its curious and original reefing mechanism.

In the type referred to the annulus is made up of six, eight, or more segmental frames, each carrying a number of fixed vanes and pivoted on axes which are tangential to a circle described on the wheel face. This wheel is reefed, both automatically and by hand, by causing the sail frames to turn on their axes, so that, when fully reefed, the frames assume a position parallel to the main axle, and are then quite ineffective, the mill being thereby stopped. Intermediate positions, of course, place the vane frames more or less obliquely to the wind by means of a large rudder in the wake of it. In some cases the reefing gear is actuated by a centrifugal governor; the arrangement is analogous in action to an engine cut-off gear. This mill, when seen at rest with the sails fully reefed, presents a very wreckish, dilapidated, and generally startling appearance. It is strongly suggestive of a large umbrella which has had its ribs unshipped and has otherwise come to grief in a gale of wind. These annular sails certainly make a much neater form of wind motor than the old four-sweep sails, and will probably quite supersede them eventually. They are much smaller and lighter for a given power with the same wind, running at higher speeds than the old type. They range in size from 8 ft. 6 in. in diameter to about 50 ft.

Mr. Alfred R. Wolff, of New York, perhaps the best living authority on annular windmills, roughly computed that in 1885 there were several hundreds of thousands of these in use in the United States. The

above gentleman has given us some useful figures as to the cost of wind power with these motors. The cost is not nil, as some have assumed. According to Mr. Wolff, the average total cost of the power, including interest at 5 per cent. per annum on total first cost of mill, and other 5 per cent. per annum on first cost—for repairs, depreciation, attendance, and oil—makes a total of 4·8 cents per useful horse power per hour. In one case, a 30 ft. mill developed (in pumping) 2·4 horse power at 2·5 cents per horse power per hour.

According to observations of the United States Signal Service, the power of good annular sail windmills is as the proportional squares of their diameters, and inversely as their velocities. For instance, a 10 ft. mill making 65 revolutions per minute in a 16 mile breeze will develop, say, 0·15 horse power; a 20 ft. mill in the same breeze, and making 40 revolutions per minute, develops 1 horse power; while a 50 ft. mill in the same wind, and running at 18 revolutions, gives 12 horse power.

Professor Blyth, of Montrose, has devoted much time and ingenuity to wind motors applied to generating electric currents, having made and tried numerous forms of wind wheel and vane, some giving a high efficiency. He has even laid down a wind-driven electric lighting installation (experimental) with some success in the Scotch village of Marykirk.

Smeaton, some years ago, made a series of valuable and interesting experiments with windmill sails (the old type, of course), and on these our existing tables of wind pressures at different velocities, etc., are mainly based.

A wind wheel or fan has occasionally been employed to drive a boat's propeller. One instance was on the City of Ragusa, a little (3 ton) craft, which successfully crossed the Atlantic some years ago.

In conclusion, a few words must be said about a third type of wind motor, although it is not nearly so efficient as the other two, viz., the horizontal windmill or wind wheel. This is seldom used, except where height is restricted, and that is rarely the case.

The usual type of horizontal windmill consists of six arms, springing from a central boss on a vertical axle. At the end of each arm is a vane pivoted off its center. As these revolve, the wind, first acting on the broader side, lays the vanes flat against the arms, being held there by a stop and exposed to the full wind pressure. Later in the revolution, its relative position to the wind being changed, it is taken aback, and swings around so as to feather by presenting its edge to the wind until it completes the cycle by coming into its first position.

Another form depends on the valvular action of sails composed of a number of slats pivoted on one edge, and slightly overlapping, so arranged that the slats or valves are kept closed by the wind, and impervious to it on the driving side of the axis, while, on the return, non-effective side, the rear of the valves being then presented to the wind, it blows them wide open, and passes through freely. This is the action which is popularly, but erroneously, believed to take place with a bird's wing feathers when flying.

Moerath's wind wheel, which was first exhibited at the Paris Exposition of 1867, is on the principle of the inflow turbine. It has 32 curved vanes, surrounded by a ring of as many tangential guide plates, the wind exhausting at its center. The guide plates are hinged to the periphery of the fixed framing, and can be partly closed automatically, through the agency of a centrifugal governor and train of gearing, to regulate the wind supply to the wheel.

The foregoing is a very complex and costly piece of mechanism; and in view of the low efficiency of the horizontal wind motor, together with the high cost (both prime and of maintenance) of this variety in particular, it would probably never pay to run it.

The most recent wind engine is of the horizontal type, and is known as the "Rollason wind motor." In this the vanes are segments of a hollow cylinder (bent sheet iron), mounted at the ends of two sets of arms, keyed on a vertical shaft or axle. The concave side of the vanes is, of course, the driving side. A movable wind shield, also of segmental form, is used to screen the returning convex side of the vanes, and is shifted round to suit the direction of the wind. This type of wind motor has been made up to 5 horse power (estimated) when running with an 18 mile breeze.

APPARATUS FOR TRANSFORMING PHOTOGRAPHS.

The first occupation of an amateur photographer, as soon as he comes into possession of his apparatus, is usually to take pictures of his family and his friends. But, after he has represented them isolatedly and in groups, in varied costumes, and which is quite quickly done with the rapid processes now at one's disposal, he is obliged to fall back upon other work. One of our friends, Mr. E. Archdeacon, has asked himself whether it would not be sometimes amusing to be able to use the negatives obtained for the making of caricatures, and to this effect has been led to devise an ingenious apparatus which permits, besides, of a few other ingenious applications. Several processes that allow caricature photographs to be obtained have already been described, but these, as a general thing, necessitate the use of a camera and objective, while here this is not necessary, since the apparatus is applied simply to a process of printing the ordinary negatives that one is already in possession of.

The transforming apparatus is a derivative from an already described shutter that consists of a curtain provided with a narrow slit, and that during exposure passes rapidly as near the sensitized plate as possible. The image is thus made by successive sections, and, if the slit is shifted too slowly with respect to the speed of the subject photographed, there occur distortions that vary according as the slit moves in the same direction or an opposite one or at right angles with the direction of the models. Such distortions may be very slight and scarcely perceptible, if great rapidity be given the slit, and the direction of the motion be well chosen. The transforming apparatus, on the contrary, far from lessening such defects, exaggerates them and permits of varying them.

It consists of two frames, R (Fig. 1, No. 1), hinged together and opening like a book. In one of them slides a board, A, upon which is mounted the sensitized paper,* and in the other a second board, E, upon which is fixed the negative, C, that is to be distorted. The sensitized paper, the negative and the boards thus become interdependent and the former follow the movement of the latter. Between the two frames is placed a piece of black paper, D, provided with a narrow slit, F, whose form can be varied to infinity—straight, oblique, sinuous, etc. This paper is pinched between the two frames when they are closed (Fig. 1, No. 2) and remains immovable, whatever be the motion of the slides, A and E.

It is upon the displacement of the latter that will depend the extent of the distortion, which will be in the direction of the length or breadth of the negative, according to the position in which the latter has been fixed upon its slide. Things having been thus arranged in the dark room, it will be seen that if the negative be exposed to the light and the two slides be drawn out at the same time with equal velocity, the different parts of the negative will be printed through the slit upon the corresponding parts of the sensitized paper, and in the development there will be no distortion. But the same will not be the case if the sensitized paper has not the same velocity as the negative. If it moves more slowly, the image will be squat, and if it moves more quickly, it will be elongated (Fig. 2). If the slit is sinuous instead of straight, one can imagine what an odd effect will be produced. It is easy to calculate in advance the distortion that will be obtained upon determining the relative velocity of the two slides. In order to succeed in giving such velocity easily and practically, a sort of pantograph, H (Fig. 1, No. 2), fixed to the side of the apparatus, is employed. Two rods, M and N, are attached to rings at the end of the slides, and two screw clamps permit of arresting them along a lever whose bearing point is upon the prolongation of H. It will be seen that if the free extremity of this lever be pulled, the velocity of each slide will be in direct ratio of the distance of the point of attachment of the rod that corresponds to it from the bearing point of the lever. Thus in the position represented in the figure, the slide, E, or the negative, will move more slowly than the slide, A, or the sensitized paper. The image will be elongated and that, too, to the exact extent desired.

It hence results that through this process it is possible to succeed in obtaining enlarged images without distortion. It will suffice, in fact, to elongate them in the first place in one direction and afterward in the other to the same extent. To this effect, a sensitized plate instead of the paper must be put upon the slide, A, and a positive, doubled in length, for example, be made upon glass. With this positive there may be made a negative, which, afterward arranged in the apparatus in order to be doubled in width, will give upon the paper an undisturbed and enlarged image double the size of the original negative.

It will be remarked also that a very slight distortion may often be considered a simple retouching. For example, in the case of a too elongated figure, it will be possible to utilize the apparatus for obtaining a slight shortening, and, reciprocally, a too stout a person may thus be made more slender without going so far as distortion.

If, instead of being content to simply do printing by this process, one desired to have a direct negative, it would be necessary to mount the apparatus upon a camera, the negative, C, being suppressed and the slit being movable—transformations that bring us back to the plate shutter spoken of in the beginning. Mr. Archdeacon has in this manner conceived a curious method that permits of obtaining an entire panorama of 360 degrees gathered together upon a 5 by 7 inch plate, and of afterward reconstructing it, by printing, in its normal dimensions. Let us suppose an apparatus pivoting around its axis, like the Damoiseau apparatus, for example. While it is making a complete revolution, the slit displaces itself in the same direction, but with a slower velocity, so calculated that it shall, during this time, have traversed the entire plate. Under such circumstances the entire panorama becomes printed upon the sensitive plate, but the image obtained is contracted. The ratio between 360 degrees and the angle embraced by the objective gives the extent of the reduction. If, for example, the objective embraces an angle of 90 degrees, the contraction of the image will be a quarter. With the process described above, it will suffice, then, to enlarge the negative four times in the direction of the length in order to have a positive representing the panorama without distortion.

We may add that, up to the present, no trial of this original application of the transforming apparatus has been made, but we have desired to mention it in order to show the resources that this mode of printing is capable of presenting.—La Nature.

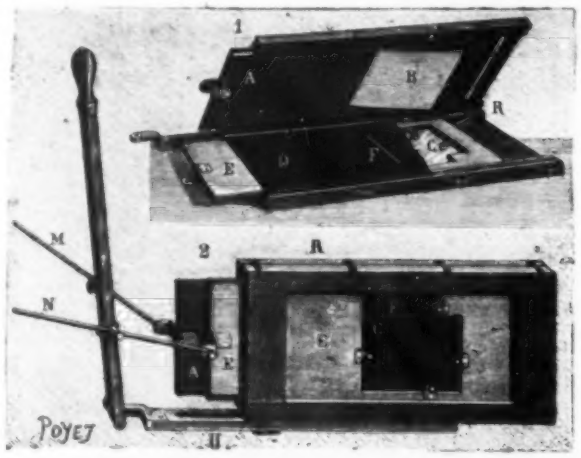


Fig. 1.—APPARATUS FOR TRANSFORMING PHOTOGRAPHS

Fig. 2.—FACSIMILE OF AN ELONGATED PHOTOGRAPH OBTAINED WITH THE APPARATUS.

* Gelatino-bromide paper, which is rapidly impressed and gives an image through development.

JOSHUA REYNOLDS.

Joshua Reynolds was born at Plympton, in Devonshire, July 16, 1723. On the 16th of October, 1752, he had returned to London from his first student journey through Italy, and very soon after had become the first painter of the great metropolis. In 1769 he became the first president of the newly founded Royal Academy, of which he remained the leader until 1790. He died the 23d of February, 1790.

In his journey through Italy, Reynolds sought solely to progress in art; to advance in the art of seeing, in the art of representing. Above all other things he sought for beauty, but the beauty which was constantly before his eyes in Italy was entirely different from that which was in favor in London. They had ceased to paint men as human beings in that city. They liked better to represent them as gods, heroes and kings. Even in portraits they attempted the representation of the higher forms of art. Their figures were placed near immense pilars and heavy draperies; the head was proudly raised, the neck turned boldly to one side, the hand was given strong expression; to the most ordinary citizen was given an appearance as of something princely. They would have beauty at any price, and had forgotten that this could be found in simple nature alone. But nature even was no longer seen as simple, and if anything was painted exactly as it was, it was considered common. Reynolds went to Italy as a man of simple art, if one may so speak. Raphael did not influence him. He studied him, but principally with a feeling for the excellence of his work. His models were Guido Reni and the Venetians. And because the Dutch sought, above all else, to express the spiritual power of pictures, he took his sketch book in his hand and tried to find from them the division of the light and shade, entirely untroubled whether men or gods, landscapes or animals, were represented. He wanted to learn how to make an effective picture, and believed this was to be found in the proper comprehension of the distribution of light.

So he went through this lauded land of art as a man with his senses on the alert, and as an artist of strong native comprehensive skill, but also as a man who had a strong and delicate nature to bring to bear on his studies. He placed the greatest stress, however, on an exact knowledge of nature. The habit of showing with exactness that which is seen seemed to him the first condition of expression. He did not wish to copy nature painfully, as illusion is not art; nor did he desire to represent the merely unusual; but to seize and hold the collective qualities. Beauty and nature impressed upon him the same thing in different ways; nature was to him the source of all excellence. In portrait painting, his own peculiar branch, he held fast to this maxim. He sought to find the chief charm

of a picture in its likeness; but to him this was less the drawing of a feature than the perception of the soul, the whole creature. Indeed, he held the representation of the human for the important thing, even to the suppression of the mere likeness of features. He did not wish to paint men as he saw them in this or that moment, but as the impression that a closely observing friend would receive of their inner life.

There is thus found a not insignificant portion of himself even in his portraits. Reynolds lived in a time in which the "Third Estate" pressed on society. He painted many distinguished people, his pictures bore the proudest names of the land, and yet his inclinations were from aristocracy, and he had a taste for that simple grace which the French painted in a preceding period of art. But he considered this less valuable than the art which represented more exalted things. And this loftiness led him to simplicity, to a certain temperance, which formed a barrier to affectation. It was a homely greatness which he strived to attain. It is true that simplicity alone had but little virtue for him; but he considered that it should stem the overflow of youthful fire; it should entice the violent demonstrations of mental strength into quiet ways; it should make life conform to lawful forms.

Reynolds was a man of lawful tendencies, of that homely propriety which then expressed itself in England and which still exercises a strong influence on the entire British people.

Reynolds was very diligent, working in his studio as long as the daylight allowed; he demanded only moderate prices, but he painted as many as 150 pictures in a year; he also allowed himself a number of assistants, who painted the clothing and put in the backgrounds; but he permitted no picture to leave his hand which was not complete. With a sure hand and great mechanical dexterity he worked steadily and temperately until he finally had an income of $20,000 a year, which allowed him to exercise that proud modesty which his friends celebrated. He would, said one of these, have worn a crown of diamonds without altering his mien.

He has been long dead, but for his countrymen he is still living. And because he was entirely national and modern, he is in the way to be considered "classic" by all nations and for all times. His fame advances with each succeeding year.—Translated for Public Opinion from the German of Cornelius Gurlitt, in the Stuttgart Vom Fels zum Meer.

THE NEW PROTESTANT CATHEDRAL, BERLIN.

WE publish an engraving, for which we are indebted to the Illustrirte Zeitung, of the new cathedral at Berlin, as it will look when completed. The accepted design is the work of Prof. Julius Raschdorff. The Prussian Landtag appropriated $2,400,000 for the erection of the building.

The laying of the corner stone by the Emperor was celebrated with great pomp on the 17th of June. The spirit of a great history gave the fete a special consecration, making it a day of honor in the church life of Germany. It was a fete of national significance, this laying of the corner stone of a great cathedral, a worthy Protestant house of God that will stand for centuries as a token of the faith of the people and as a mother church for the nation. It is a realization of the wishes expressed years ago by the Queen of Prussia. Most of the buildings in the neighborhood of the cathedral square were decorated for the occasion, and the square itself looked like a pleasure garden, with its banners and flags and the shields bearing the initials of the Emperor and Empress, and the people who crowded the streets and the square were very enthusiastic, making it a most memorable occasion.

PNEUMATIC TIRES AND RECLAIMED RUBBER.

THE reclaimed rubber business has assumed such large proportions of late years that when a new article containing rubber as a constituent comes on the market it soon starts inquiry as to whether it can be reclaimed, as old rubber boots and shoes and other rubber articles now are. Thus it is that considerable interest is evinced in the pneumatic bicycle tire, which is beginning to come on the market, as those that were first used are now being discarded either to make way for newer tires or else because of its being worn out. The pneumatic bicycle tire is but three years old, and has not as yet had sufficient time to become firmly established on the market, but considering the quality of rubber in them, they should in time find quite a ready sale. These pneumatic tires contain a very fine quality of rubber, the better grades having a large percentage of the finest Para rubber.

To get a high grade pneumatic tire it is necessary to get a maximum of strength with a minimum of weight. Thus it is that for the past three years, or ever since the pneumatic tire was first introduced on the market, perfection has been sought in this respect.

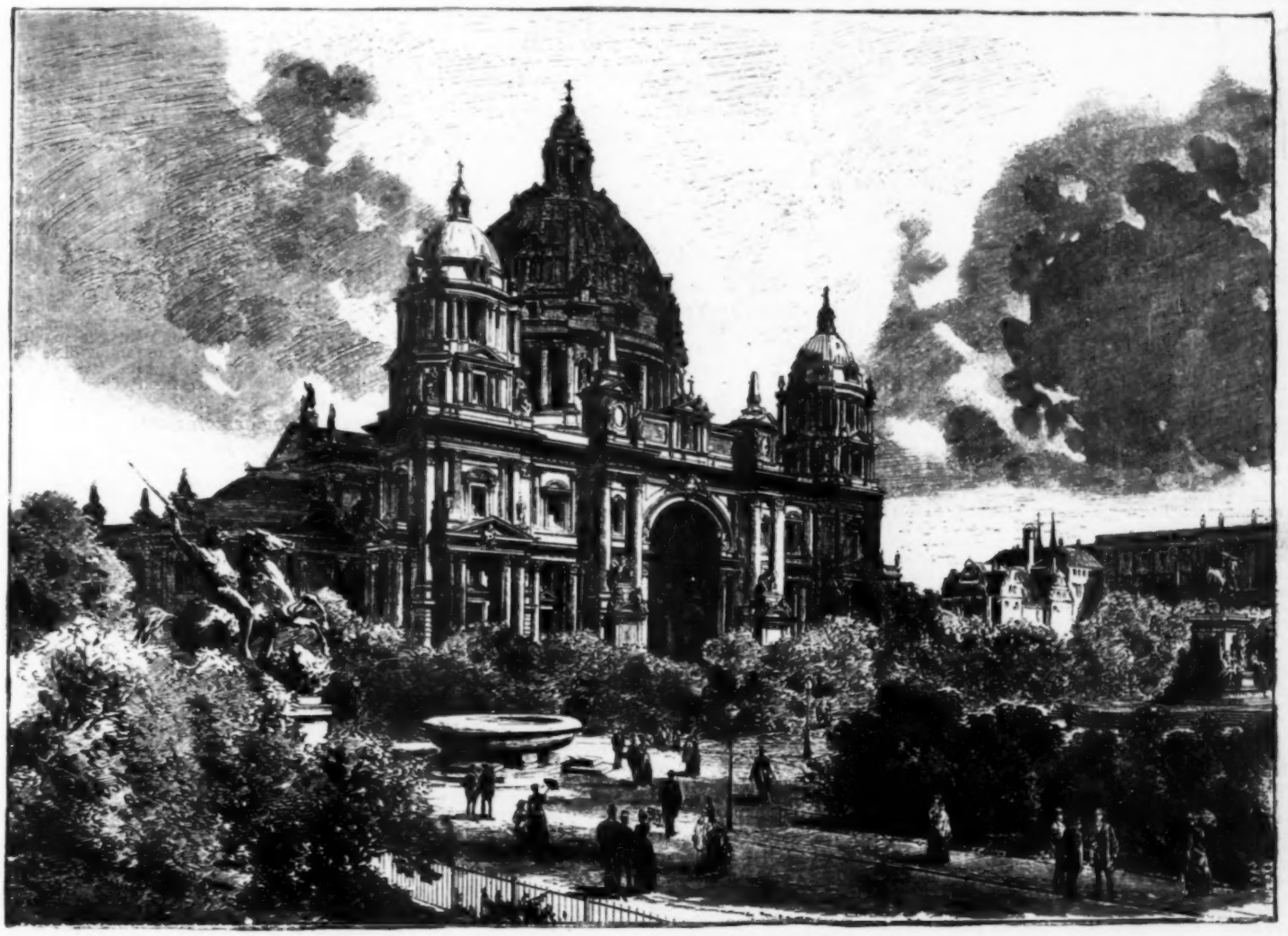
This year's tire is indeed light in comparison with those made in the two preceding years. Those used on racers weigh but 1¼ pounds apiece, and it is thought this will be the standard weight of tires for such machines. The ordinary road machines have tires weighing from three to four pounds apiece. In the short space of three years, since the pneumatic tire was first introduced, almost 5,000 patents have been taken out on this style tire, and though the best of these have been selected by the large manufacturers, the pneumatic tire business has not as yet reached the stage of permanency, and probably will not for another year at least.

With the increase in the number of bicycles and the greater appreciation of good riding, there is, of course, a more general demand for the best machines, and consequently the best tires. To-day no stock is too good for the making of high class tires. The cotton fabric which gives the tire its strength, with a minimum of weight, is made from a high grade Sea Island cotton. The tube is lined with a sheeting of rubber, which makes it very nearly airtight. The outer coat of rubber, made from the best Para, makes the tire watertight and gives it wearing qualities.

There are hardly any rubber goods made that contain proportionally a greater percentage of pure Para gum than bicycle tires, yet there does not seem to be much call for them. A New York dealer some months ago made inquiries in this market for pneumatic tires, but as there are not many to be had, and particularly at that time as there were very few on the market, no sales were made which would make a market price. Notwithstanding the good quality of the rubber in these tires, they will not bring much of a price as scrap until there is a market for them, as there is for old rubber boots and shoes. Even then they are not very likely to bring a high price.

We are led to believe this by the way rubber bands and rubber webbings sell. They contain the purest Para rubber of any goods made and have an established market, notwithstanding which they will not bring over 6 cents per pound, against 4¼ cents, the price which rubber boots and shoes bring, and the latter are a far inferior stock.

The increased manufacture of bicycle tires will be of much greater benefit to the sellers of fine Para than any one else. The business has already assumed those proportions where it consumes more Para than any one thing outside of boots and shoes. It is estimated that the latter consume fully 75 per cent. of the total Para sold, and bicycle tires about 10 per cent. of it. If our pneumatic tire manufacturers succeed in establishing a European market for their goods, as they hope to, one of the largest American concerns preparing to introduce their tires there this fall, then the consumption of Para in this one line will be very large. It is thought now that the agents sent from this side will be successful, inasmuch as our manufacturers are far in advance of those in Europe in making bicycle tires, as in almost all other kinds of goods of which rubber forms a component and important part.—Boston Commercial Bulletin.



THE NEW PROTESTANT CATHEDRAL, BERLIN.

FROM THE DESIGN OF PROF. JULIUS RASCHDORFF. DRAWN BY G. THEUERKAUF.

SOME DIFFERENCES BETWEEN THE ENGLISH AND AMERICAN PLUMBER.

ACCORDING to an article in the Sanitary Plumber, there are a great many radical differences between the work of the American plumbers and the English workmen in the same line; in fact, the plumbing business in Great Britain and America is carried on upon entirely different lines. On the other side of the water the plumber habitually does roofing, makes pipes and flashings, uses lead wastes, makes lead fixtures, is usually a gasfitter, and very generally does decorating work. To a builder he is very frequently a general utility man.

It is very rare to find an American plumber in the roofing business. In fact, the two lines are usually as separate and distinct, in all except the smaller shops and those with questionable characters, as the dry goods trade and the grocery trade would be. On the other side the union of the two trades was a very natural one, because in the early days the lead roof was one of

the most common coverings for buildings, apd the plumber, being a lead worker, found quite as much to do on the roofs as with other parts of the drainage of a house. In fact, it seems that the plumber's original business was that of the sheet lead worker, and consequently he was really more of a roofer than anything else, and, being a roofer, flashings were a part of his work.

The use of the outside waste and vent pipes is something that is very difficult for the American plumber to understand. In such work open joints or their equivalents are necessary for taking up expansion and contraction. The fact that the winters are comparatively mild prevents the wholesale destruction of the plumbing which would take place in this country with a similar construction. The outside position of the pipes renders them less liable to destruction by vermin than if they were placed within the building. The fact, however, remains that the winters are frequently severe enough to produce frost, and at such times it is difficult to see how a lead system on the exterior wall of a house could be operated without instant destruction or, at least, stoppage. All the English authorities on plumbing, while speaking of the inside work and recommending it, fall back on the outside work as the style which, after all, seems best suited to the demands of the people. The English plumber still does a great deal of lead work which in this country has been superseded by materials obtained from the manufacturers ready for use.

Lead trap making is, in this country, a thing of the past. Even the bottle trap is now a commercial article, and there is nothing remaining that needs to be made in the shop. Service boxes and drip trays are no longer made of lead, so that the modern American plumber has little to do in general plumbing work beyond bending and fitting pipe and making safes. In the better class of work even safe making is disappearing and water-tight floors are taking its place. It is not an unheard of thing to find first-class jobs in this country where not five pounds of lead have been employed on the whole of the plumbing work.

Here, as in England, gasfitting is recognized, and has been for many years a legitimate part of a plumber's business. In England the union of gasfitting and plumbing seems to go back to the very beginning of the art of conducting gas in pipes, and the continued use of the so-called "composition" pipe, which is a bendable pipe like lead, makes it there a very proper branch of the trade. Here, on the other hand, the plumber has taken to the use of iron, brass, and other hard metal pipes to such an extent that he has to have his shop fitted with most of the tools for handling wrought iron pipe. Hence he naturally combines gasfitting with wrought iron pipe work as a proper, legitimate branch of his business.

In this country there is a constant advance in the styles and manufacture of plumbing goods of all kinds. There is nothing used by the plumber, from a joint for lead pipe to a complete set of bath room fixtures, that he cannot buy ready made. The work is becoming more and more a trade in which science and the ability to set up ready made fixtures and ready jointed pipe is more essential than skill in working of lead. The schemes of plumbing and drainage made necessary by our tremendous buildings are of a character to call for scientific knowledge of the highest class, but the manual skill needed beyond that of making a perfect screw or caulked joint does not seem to be called for. Job after job of fine plumbing work is turned out, and the master plumber will tell you that he "did not use a pound of lead." It requires very little thought, therefore, to see that the tendency of plumbing work in the United States is diametrically opposite to that of Great Britain, and it remains to be seen whether in the future the lines of advancement are to be still further diverging or in common.

NEW CELLULOSE DERIVATIVES.*

By CLAYTON BEADLE.

NEARLY two years ago, my colleagues, Messrs. C. F. Cross and E. J. Bevan, and I, when working on the behavior of "mercerized" cellulose toward various reagents, discovered a new class of soluble cellulose derivatives. The ultimate products obtained from these promised to be of so much value and interest that we followed the work up with the greatest possible speed, one of us devoting his whole time to the prosecution of this work. It has resulted in the production of a large range of products, which we have every reason to believe are of great value. Mr. Arthur D. Little has been connected with us in working out the various developments over here. The results obtained by him, we believe, have largely added to the value and scope of our process. We published a brief account (Chem. Soc. J., 1893, 837) of our early work on these compounds and indicated their probable line of developments. (Soc. Chem. Ind. J., June 30, 1893.) After nine months' further work we are encouraged in the belief that the predictions we then made are on the eve of fulfillment.

"MERCERIZED" CELLULOSE.

The action of strong solutions of caustic soda upon cellulose has been the subject of study for many years; but the susceptibility of cellulose to interact when so treated has only recently claimed attention. When cellulose (e. g., cotton wool) is treated with a solution of caustic soda containing fifteen per cent. NaOH, the fibers are seen under the microscope to swell up and increase enormously in diameter, undergoing all sorts of contortions and twistings. The characteristic markings of the fibers are very much intensified, which affords a means of identification. The cell wall absorbs within itself a considerable quantity of the solution. When this mass is washed with water, the soda is entirely removed. If pure cellulose be used, the weight obtained is somewhat greater than that of the cellulose taken. This effect has long been known as "mercerization."

Mercer, the first to study this, believed it to be due to a combination between the alkali and the cellulose in the ratio of $C_{12}H_{20}O_{10}$: 2NaOH. The question whether "mercerization" is the result of a chemical union between the cellulose and soda, or the absorption of the soda by the cellulose, resulting in the hydration and gelatinization of the latter, to form a colloid modification, must be left at present unanswered. The soda solution entering en masse into the cell wall and its easy removal by washing, would lead us to the latter conclusion; but for various reasons, which we shall see hereafter, it would appear that some sort of a union between the soda and cellulose takes place. Mercerized cellulose, when washed and dried, is found to correspond with the formula $C_{12}H_{20}O_{10}$, H_2O. The hygroscopic moisture is found to have increased from 6·5 per cent. (the normal figure for cotton cellulose) to 10 per cent. In common with most cellulose hydrates, it gives the starch reaction with iodine. This is beautifully demonstrated by placing drops of caustic soda solution of different strengths on Swedish filter paper; after a few minutes, washing the same until free from soda, it is dipped into iodine solution. The portion treated with caustic soda will be turned deep blue if the soda is up to "mercerizing strength." If the soda used is below this strength, a circular fringe of blue will be developed on the edge of the spot where the water has evaporated and so concentrated the soda. This test gives us a means of determining whether the right "degree of mercerization" has been reached.

CELLULOSE BENZOATES.

About three years ago we began to study the reactions of cellulose in presence of strong alkaline solution and obtained cellulose benzoates by shaking with benzoyl chloride. The yields and analyses showed variations between the di and tetra benzoate, according to conditions of working. The yield of benzoate is limited, as might be supposed, by the "degree of mercerization." By dissolving certain hydrated modifications of cellulose in caustic soda, products of a uniform composition were obtained, giving a higher yield of benzoate (vide supra). The activity of cellulose in this direction led us to study its behavior in regard to the vapor of carbon bisulphide.

CELLULOSE THIOSULPHOCARBONATES.

We found that when so-called "alkali cellulose" is treated with carbon bisulphide vapor, at the end of three hours the mass will have changed to a deep golden yellow. This, when treated with water, swells up to a gelatinous mass and finally dissolves, forming a very viscous solution, about the color of treacle. The reaction that takes place may be expressed as follows:

$$X.ONa + CS_2 = CS\begin{matrix}\diagup OX \\ \diagdown SNa\end{matrix}$$

Alkali Cellulose. Cellulose Xanthate.

where X represents the reacting unit of cellulose. We have then cellulose xanthate formed, which is soluble in water, with the formation of the solutions as above described.

COAGULATION.

This solution lasts only for a limited time. In a few days it is found to have set to a solid coagulum which is no longer soluble in water. The action which takes place is simply a reversal of the above, or a dissociation of the xanthate, which is readily brought about in presence of water.

$$CS\begin{matrix}\diagup OX \\ \diagdown SNa\end{matrix} + H_2O = CS_2 + X.OH + NaOH$$

Cellulose Xanthate. Cellulose.

The tendency of the solution to coagulate is conditioned by the amount of water present. Dilution, as might well be supposed, has been found to favor dissociation. The life of the solution is then greatest when the minimum quantity of water is used to bring the xanthate into solution. The color of the solution is chiefly due to the presence of thiocarbonate of soda, which is formed from some of the CS_2 and NaOH splitting off by gradual dissociation.

PROPERTIES OF THE SOLUTION.

Sulphuric and most mineral acids immediately precipitate the cellulose with the evolution of sulphureted hydrogen. Acetic and many weak organic acids evolve sulphureted hydrogen without precipitation of cellulose, the solution becoming nearly white and colorless, but much more liable to rapid coagulation. Bisulphite of soda or sulphurous acid decolorizes the solution without the evolution of sulphureted hydrogen, if carefully added. Zinc sulphate or chloride precipitates the zinc salt in horny flakes, which can be washed and easily redissolved in weak soda. Alcohol or brine precipitates the cellulose as thiocarbonate, which can be washed free from by-products and dissolved in water.

VISCOSITY OF SOLUTION.

This solution is very viscous, and very readily undergoes coagulation. The viscosity of the crude solution depends upon many conditions. It is possible to prepare two solutions from the same cellulose, one containing five per cent. and the other twenty per cent. of the same viscosity. If the cellulose has been treated with caustic soda some weeks before treatment with CS_2, the viscosity of the solution is very much reduced. Raising the temperature of the alkali cellulose has the same effect. A solution of greatest viscosity is got by treating with CS_2 immediately after mercerizing. This gives us, when cotton is used in a seven per cent. solution, a viscosity equal to glycerine, measured by rate of flow.

The determination of the specific gravity of solutions of various strengths is not very satisfactory, but it clearly indicates that the specific gravity decreases with decreased viscosity due to increased age of alkali cellulose.

Increased temperature shortens the life of the solution by inducing coagulation. A solution that would last forty days at 35° F. would coagulate in twenty-five days at 47° F., or in six days at 65° F. When a solution is spread on the surface of glass and exposed to a temperature of about 250° F., the coagulation takes only a few minutes. This, when washed free from by-products, comes off the surface as a transparent film.

Mass has a great influence on coagulation; a small sample of thirty grammes coagulates much sooner than a 400 pound lot of the same solution when both are kept at the same temperature.

Coagulation is induced by exposure to the air, probably due to the presence of carbonic acid, which is found to aid dissociation of the cellulose thiocarbonate, by forming sodium carbonate and liberating CS_2.

PROPERTIES OF COAGULUM.

A solution when once coagulated, although it retains the water required for its solution, is no longer soluble. If a coagulum contains much under ten per cent. of cellulose, it will contract on itself, retaining the form in which it was cast and separating from the water and soluble by-products until it contains about ten per cent. of cellulose and ninety per cent. of water. On the other hand, if the coagulum contains a high percentage of cellulose, it will expand and take up water. This coagulum will not dehydrate by treatment with alcohol. At this point it remains in a state of equilibrium so long as it is kept immersed in water. When the washed coagulum is taken out of the water and placed in air, by a gradual process of integration the mass gradually contracts on itself until the whole of the water is eliminated. The resulting material is a hard, compact, horny substance, having a specific gravity of 1·5.

DECOLORIZED ACETIC ACID SOLUTION.

The crude thiocarbonate solution, when decolorized by the addition of suitable reagents, shows some marked peculiarities. When acetic acid is added, sufficient to render the solution just acid, on standing for some time the solution will have increased in viscosity and developed a marked alkaline reaction. The acetic acid decomposes the sodium thiocarbonate present in the solution, and, as dissociation proceeds, CS_2 is given off and caustic soda formed. If a non-viscous solution has been used, the viscous form can be induced by this method. The solutions coagulate a few hours after the addition of the acids unless kept very cool, and are more stable in dilute than in strong solution. A fresh coagulum from a strong solution can be rendered soluble by the addition of water and agitation, and the life can be extended for a considerable time by adding successive quantities of water at regular intervals and agitating. Alum may be used in place of acetic acid.

EFFECT OF SULPHUROUS ACID ON SOLUTION.

When sulphurous acid solution or sodium bisulphite is used in place of the above, the behavior is somewhat different. The sulphur compounds are, for the most part, converted into thiosulphate, and we have a more permanent solution. The influence of mass is here very much marked. On placing the solution in tubes of different diameters, the smallest coagulates first, and so on, in order of diameter. The life of the solution is about thirty hours in small quantities, but it can be kept for six days in large quantities at the same temperature. It is more stable in dilute solution and the fresh coagulum is readily dissolved by ammonia.

PRODUCTS PURIFIED BY ALCOHOL OR BRINE.

The product got by purification with alcohol or brine is found on analysis to contain less sulphur and soda than the crude material, and by repeated treatment these may be got down to one-tenth their former quantity, but are found to bear about the same ratio to each other. As the S and Na_2O diminish, the solutions are found to be more viscous and less stable. It appears that the reacting unit of cellulose is not constant, and that the molecule may be at least $4(C_{12}H_{20}O_{10})$. The fact that two parts of cellulose in 1,000 parts of water, as a decolorized solution, will coagulate without change of volume, leads us to believe that the molecular weight of this cellulose is very high.

BENZOYL CHLORIDE REACTION.

When a crude solution is treated with benzoyl chloride, the cellulose is eliminated as a cellulose benzoate. In view of this fact, we may be right in ascribing the following formula to the compound:

$$CS\begin{matrix}\diagup OX.ONa \\ \diagdown SNa\end{matrix}$$

X representing a cellulose residue of variable molecular weight and reacting as an alkali cellulose.

COMMERCIAL PRODUCTION.

In preparing large quantities of this cellulose compound, we take a moist, disintegrated cellulose and incorporate it with strong caustic soda solution by agitation under considerable pressure. The cellulose, when acted upon by the soda, swells up and absorbs all the solution, becoming flaky. This is passed through a sieve in order that it may be of uniform density and occupy as much bulk as possible. This process takes about thirty minutes, and one hundred and fifty pounds of mercerized product is obtained at each mixing. One cubic foot of the material ready for treatment with the CS_2 weighs about fifteen pounds. This is brought in contact with CS_2 vapor when the mass has been carefully raised to 80° F. and kept in agitation. The reaction develops enough heat to raise the temperature to 105° F., when at the end of one hour the reaction is complete. The material still retains its former structure, but has changed in color to a golden yellow. It is discharged into, and carefully mixed with, its own volume of water. In seven hours the mass has become a homogeneous, stiff dough. To obtain a clear solution from this, it is passed, together with its own weight of water, through a centrifugal pump, and to free it from mechanical impurities it is passed under pressure through a filtering medium. The amount of caustic soda required is expressed in its simplest terms by the ratio $C_6H_{10}O_5$: 2 NaOH. The proportion of CS_2 used is expressed by the ratio CS_2 : 2 NaOH.

The most favorable conditions for the interaction are:

$$C_{12}H_{20}O_{10} : 2\ Na_2O : 2\ CS_2 : 35\ H_2O.$$

THE PRODUCTION OF CONTINUOUS FILMS.

When dehydrating agents, such as brine or alcohol, act on the cellulose thiocarbonate solution, the effect produced is dependent upon the constitution of the solution. Thus, if a fresh solution is used and brine added, the flocculent precipitate obtained is entirely redissolved in water. If the solution has been made some days and approaching the point of coagulation,

* Read at the stated meeting of the Franklin Institute, April 17, 1894.—From the Franklin Journal.

the precipitate so formed is during precipitation converted into insoluble cellulose. If some of this solution is spread as a varnish on a glass plate, and immersed in brine, the cellulose can in a few seconds be stripped off the surface in the form of a film. We endeavored to take advantage of this for the production of continuous films, and after erecting six machines, each of which was a step in advance of the last, we devised a machine which produces and reels a film in a continuous web. The thick solution, which has been kept till on the point of coagulation, is spread on the surface of a revolving cylinder half immersed in a bath of brine. The solution is spread by means of an adjustable doctor, attached to side deckels which regulate the width of the film required. The film as it leaves the brine is stripped from the cylinder and passed through a series of vats for washing, decoloring, dyeing and finishing. It can be dried by passage over steam cylinders and reeled. The film when in the web, before passing on to the drying cylinders, can be grained or stamped by rolls carrying designs in imitation of any surface. Cellulose films prepared by this method have an affinity for many aniline colors not shared by any other form of cellulose. Its power of absorption of various substances when in the half-finished state enables us to give to the finished product a large range of properties.

It becomes dyed so readily with some aniline colors without a mordant, that the operation can be done in the web as it passes over the machine. When dried and finished it becomes resistant and loses considerably its chemical activity.

COMMERCIAL PRODUCTION OF THICK FILMS.

(1) From crude coagulum. In order to prepare thicker films the solid coagulum is cut up into pieces of any desired thickness. These are washed to free them from by-products, and treated for some time under pressure, and calendered. By this means we are able to get a large range of products. Calendering has a marvelous effect on the films, if they are not thoroughly dehydrated. The material of the film flows under great pressure, increasing the area and decreasing the thickness of the film, and the annealing it gets very much improves its texture and strength. We have recently found it possible to forego the process of washing out the by-products, giving us films sufficiently pure for some purposes, by the following process:

(2) From decolorized coagulum. To the crude thiocarbonate solution is added a weak solution of sulphurous acid, which has the effect of decolorizing the by-products by converting them for the most part into sodium thiosulphate. The coagulum formed from this is a semi-opaque neutral jelly. This is cut up into pieces of the size required, and each piece is submitted to a process of annealing under pressure, which results in the dehydration and separation of the cellulose from the by-products. It has lately been found possible to pulverize the solid decolorized coagulum and cause it to go together into compact sheets under pressure; also to force several sheets together into one solid compact sheet. We had failed with all other mixtures to obtain a pulverized substance that would go together under pressure, and had given it up, thinking it could not be accomplished, when the above mixture was formed to answer. It is very difficult to explain this peculiar behavior of a cellulose coagulum, and why the various mixtures should behave so differently. We recognized that we are dealing with a compound in a state of very unstable molecular equilibrium and consequently very susceptible to all sorts of outside influences. The effect of pressure in promoting chemical change has recently been recognized. We think that we have here a marked instance of what pressure will do in effecting a molecular change. By changing the modes of attack on this coagulum various products are obtained, differing widely among themselves in their general properties. We have found it possible to stamp boxes direct from the coagulum, embossing and dehydrating them in one operation.

Films may also be produced by taking a continuous veneer from a revolving cylinder of the dehydrated substance.

INERTNESS OF THE DEHYDRATED PRODUCT.

This is well exemplified in its application to woven fabrics. Cotton and linen goods behave very differently in regard to their affinity for, and power of fixing, these cellulose derivatives. When gray linen is passed, through a weak solution of cellulose thiocarbonate, it is easily fixed by the film. It appears to penetrate the cell wall and build itself up in the fiber. The cellulose so fixed is not removed by the various chemical treatments the cloth afterward receives. The character of the solution used has a great effect on the finish of the cloth. It is possible to obtain a very marked difference in the feel by the addition of only two per cent., or to add to the cloth as much as twenty-five per cent. without making any marked difference. In all cases the cellulose derivative shows itself less acted upon by chemical treatment than the fiber of the cloth.

PROPERTIES AND CONSTITUTION.

Its inertness is shown also in its behavior with various reagents. Where it reacts it does so in a different way from that of cotton and linen cellulose. Its carbon percentage is somewhat lower and its weight is somewhat greater than the cotton cellulose from which it is prepared. The original molecule appears to have undergone hydration in the ratio $2C_{12}H_{10}O_{10}$, H_2O. The hygroscopic moisture varies from ten per cent. to fifteen per cent., according to the method used for its production. It is turned blue by iodine solution.

HYDRATION AND CONSTITUTION OF CELLULOSE.

It seems probable that in "mercerization" some of the OH groups are brought into play, rendering the molecule susceptible of attack by the carbon bisulphide; also that the OH groups play an important part in the molecular hydration. At the moment they are released by the dissociation of the thiocarbonate, the water present enters into a loose union with these groups, resulting in the formation of a coagulum which easily undergoes dehydration.

In a series of nitrocelluloses we prepared from cotton of varying degrees of nitration, we found that the amount of moisture retained on exposure to air varied inversely as the yield. The moisture retained, then, varied directly as the OH groups left unsaturated. This led us to the conclusion that the moisture is some function of the OH groups. If, then, as we have reason to believe, in the formation of these cellulose derivatives certain other OH groups are brought into play, we should expect to find an increased attraction for water as above noted.

INDUSTRIAL APPLICATIONS OF CELLULOSE.*

It was my good fortune to have the brilliant discoveries of my friends, Messrs. Cross, Bevan and Beadle, of London, communicated to me very shortly after their inception, and since then my time has been largely devoted to working out certain of the more obvious commercial applications of the cellulose thiocarbonate and the modified form of cellulose recovered through its decomposition.

Although in the early stages of the work numerous practical difficulties were naturally encountered, the development is at the present time going forward so rapidly that I cannot but feel that ultimately these discoveries will rank with that of Goodyear in the range and importance of their applications. Many fields in which these products will undoubtedly find place have already been entered upon, while almost daily new ones present themselves. Although the samples which we are able to show you to-night illustrate such diverse products as thick, viscous solutions which replace glue; dense, hard masses which resemble ebonite; films so thin as to be almost intangible; artificial leather, floor tiles and boiler coverings—they are to be regarded only as the first outcroppings which show the general trend of the vein.

At the present time the various industrial applications of these materials, which have been sufficiently developed to permit the production of samples, may be conveniently grouped into six classes, as follows: Applications of

(1) The crude solution.
(2) Dense cellulose in the mass.
(3) Films and sheets.
(4) Films and sheets formed on cloth backing.
(5) Porous cellulose.
(6) Various admixtures of cellulose and foreign substances, as untreated fiber or mineral matter.

In the production of almost all the samples here shown, the raw material used has been cellulose in the form known to paper makers as soda fiber made from poplar wood, but as already pointed out by Mr. Beadle, any other cheap or convenient form of cellulose is equally available.

Taking up now in the order indicated above the different industrial applications to which these new products have already lent themselves, we have to consider:

(1) THE APPLICATIONS OF THE CRUDE SOLUTION.

(a) Substitute for Glue.—The viscosity and tenacity of the solution in water of the cellulose thiocarbonates, and the fact that the compounds upon drying and standing suffer spontaneous decomposition, with recovery of the cellulose as an insoluble film, early suggested the use of the solution as a substitute for one of glue. A solution containing five per cent. of cellulose is much more viscous than a hot solution containing fifty per cent. of glue, and a ten per cent. solution is, under ordinary conditions, as heavy as can be worked to any advantage.

A one per cent. solution decolorized with sulphurous acid has been used in the commercial way for bill posting, bookbinding and the manufacture of three and four ply straw boards. No attempt has been made to wash out the salts, and in view of this fact it is noteworthy that there is an entire absence of odor in the finished product. The solution has been used in place of glue in binding a large number of books of all grades, from the cheapest to the most expensive. It will be noted upon inspection of the samples that all these books open perfectly flat at any page without straining or cracking the binding.

No extended experiments have as yet been made looking to the use of this glue substitute in carpentry, but two pieces of maple, cemented with a ten per cent. solution on a joint of one inch area, have required a strain of over 500 pounds to separate them. This compares favorably with the best glue, while in cost there is a large balance in favor of the cellulose solution. The latter has the further advantage of being comparatively little affected by a very moist atmosphere.

(b) Cloth Sizing.—A large field of use for the decolorized solution is found in the treatment of cotton and linen cloth for the purpose of securing a permanent stiffening or sizing, which is of special value in case of such goods as would ordinarily be starched. The cloth is passed through the decolorized solution, the excess squeezed out by rollers, the cloth then dried and afterward washed and bleached in the usual manner. By this treatment the threads and fibers are more or less bound and held together by an excessively thin film of cellulose, and any degree of sizing or stiffening may be obtained. Starch, clay and other fillers may be mixed with the solution and are then carried into the body of the fabric and made a part of it. Cloth thus sized or loaded becomes soft and flexible in water, so that it may be washed without difficulty, but again becomes stiff when ironed. It is expected that such cloth will find a use in the manufacture of collars and cuffs, table cloths, shirt bosoms, muslins, etc.

(c) Vehicle for Pigment Printing.—An extension of the above application is found in our new method of pigment printing, which consists in mixing the pigment with the decolorized cellulose solution, then printing upon cloth in the usual manner, then drying and finally washing. The drying decomposes the cellulose compound and causes the modified cellulose to adhere to the fibers, while at the same time carrying with it and fixing upon them the pigments with which it has been mixed. The pigments are thus firmly held within the substance of the cloth.

(d) Paper Sizing.—The addition of alum to the very dilute solution of the cellulose thiocarbonate determines the precipitation of the cellulose in the amorphous flocculent condition. It thus becomes possible to precipitate the cellulose among the fibers in a paper engine after the ordinary manner of engine sizing, and the precipitated cellulose not only sizes the paper, but brings together and assists in the retention of the fine particles of clay or other filler which would otherwise be in large part lost.

(2) DENSE CELLULOSE IN THE MASS.

This may be formed by allowing the solution to revert or decompose spontaneously with separation of the cellulose as a jelly. The by-products of the decomposition are removed by washing and the cellulose then dries down to a dense mass of specific gravity 1·53. It has much the appearance of ebonite, takes a high polish and may be easily grained or colored in the mass. It is quite homogeneous and may be worked in any direction. It has a field for use as insulating material and in the manufacture of buttons, tool handles, small articles and turned goods generally.

(3) FILMS AND SHEETS.

These may be made either in the continuous way, as pointed out by Mr. Beadle, or by pouring the solution upon a glass plate with deckel edges to control the thickness of the film or sheet, and then drying the solution down and decomposing the compound, preferably by dry heat or steam, and afterward washing out the soluble inorganic by-products. In this condition the sheets take colors very readily, and with proper care in the treatment may be made nearly as clear as glass, as will appear upon inspection of some of the samples submitted. Among the uses to which the thinnest of these films have been already put may be named the glazing of binders' board, the production of photographic films, facing blotting paper and the like. Specially lustrous and durable glazed papers are prepared by rolling on to the paper one of these thin films. If the paper is of the proper tint, a very close imitation of vellum is produced for use in bookbinding.

The applications of the heavier sheets, ranging from $\frac{1}{100}$ to $\frac{1}{32}$ or more of an inch in thickness, are especially numerous. They may be stamped into small wares like plates, trays, boxes, brush backs, shoe counters, inner soles, embossed signs, etc., or the sheets may be printed upon and stamped in almost any manner desired. Attractive covers for small books and pamphlets have been made.

(4) FILMS AND SHEETS ON CLOTH.

These are either formed directly upon the cloth or by rolling the wet film on to the cloth. Cloth faced in either way with the thinnest films is well adapted for curtain cloth, bookbinding, and many other special uses. Cloth with a facing from $\frac{1}{1000}$ to $\frac{1}{500}$ inch in thickness is valuable for many large uses. It may be caused to resemble morocco leather very closely and takes all the fine impression of the grain under a proper roll or die. It is especially well adapted to upholstery work, embossed hangings, and interior decorations. The thicker sheets have proved themselves a handsome and durable floor covering.

(5) POROUS CELLULOSE.

By working the solution in such manner that the recovered cellulose has an open or porous structure, a new product of much beauty is obtained, which is especially adapted for fancy printing, embossed hangings, book covers, fancy boxes, signs, and small articles. It has been proposed to utilize this form of cellulose as a substitute for sponges, and there is no doubt that the structure of the sponge can be reproduced.

(6) MIXTURES OF CELLULOSE AND FOREIGN SUBSTANCES.

The solution lends itself very readily to admixture with such materials as ground wood, various fibers, clay and other mineral matter, and in each case the resulting mixture of recovered cellulose and the foreign ingredient possesses some novel and useful property. In this way we have prepared floor coverings which are either flexible like oil cloth or linoleum, or hard and rigid like tiles. Various forms of insulating material have been made, together with trunk boards, embossed panels, emery wheels, and many other special articles.

The above list by no means completes the number of applications which we either have in mind or in the partially developed state, but will suffice to indicate some of the points at which these new compounds may fairly be expected to touch the arts and to justify to some extent the high estimate which I placed upon the importance of these discoveries to the industrial world. Their value and interest from the scientific standpoint have already been widely recognized.

* By Arthur D. Little.

THE GULF STREAM.

IN the North Atlantic Pilot Chart for August Lieutenant Commander J. E. Pillsbury, U. S. Navy, thus explains the origin, action and movement of the Gulf Stream:

In order to learn the action of the Gulf Stream it is necessary briefly to enter the subject of its causes. Every navigator of its waters knows that at times it is stronger than at others, and that under the same apparent conditions of wind and weather the stream is variable in velocity and direction.

The greater regular variations are chiefly due to changes in the position of the moon—a daily variation governed by its time of transit, and a monthly variation following the changes in declination. Both of these can be predicted with considerable precision.

The unusual variations come from the force and direction of the wind and the difference in the height of the barometer within and without the Gulf of Mexico. A knowledge of the action of these forces and the way by which they tend to produce the unusual changes will enable the navigator to take advantage of immediate conditions and so shorten his passage from port to port.

The cause of the Gulf Stream, and of most ocean currents, is directly or indirectly due to wind. Every wind produces a slight movement of the water over which it blows, by its friction on the particles of the surface water. As the upper particles acquire a movement the same motion is transmitted to the lower particles, thus forming a current. Although every wind causes a current, it is only persistent or long

continued wind from the same general direction that produces a current of sufficient volume to become permanent or to be felt for a considerable time after the wind has ceased. A strong gale may cause a current of half a knot, but its blow is of short duration and the current is shallow and consequently of but little volume. With the trades, predominating as they do from the eastward, and persistently blowing over a large area, the current set up extends to 70 or 80 fathoms depth, which maintains its average velocity in spite of the daily variation in its producing cause.

Any current, upon meeting an obstruction, must escape in some direction. The current from the southeast trades reaches the South American coast in the vicinity of Cape St. Roque, and it thereupon divides into two branches, one flowing to the southward, along the coast of Brazil, and the other toward the West Indies. The current from the northeast trades, flowing in the general direction of the wind, meets the obstruction of the coast of South America and of the Windward Islands. The combined currents have a partial relief by an escape through the passages of the Windward Islands, while the remainder passes along the northern side of the West Indian Islands toward the coast of the United States. The current entering the Caribbean is driven to the westward until it meets the obstruction of the coast of Honduras. Here the escape is in two directions, a part flowing to the southward and a portion toward the Straits of Yucatan.

There is another movement of the water which is more effective in producing a current along shore, and which probably contributes as much water to form the Gulf Stream as the surface current due to the friction of the wind. This is the water driven to leeward by the break of the waves. A gentle wind makes a small wave which breaks in a ripple, and by so doing throws a small quantity of water in its direction. A strong wind makes a larger wave, and in a gale every break throws tons of water to leeward. Where the wind is blowing in the same direction over a large area, like the Caribbean Sea, the effect is a simultaneous movement of the surface toward the lee shore. In the case of the Caribbean, a strong shore current is produced toward the Straits of Yucatan and to the southward along the Mosquito coast. It is from this cause that violent shore currents are set up along the coast of Cape Cod, New Jersey, and North Carolina in northeast gales. The waves are thrown toward the shore, from which the escape of the water makes the strong current that has wrecked many a vessel.

The irregularities of the Gulf Stream due to the varying wind cannot be predicted except in the most general way. An increase or a decrease of the force of the trades is not felt at all, except at intervals of seasons, because the force of the current is the result of average conditions, and a temporary abnormally strong wind in the trades region will not materially change the average. The first part of a norther in the Gulf of Mexico will probably cause a strong stream current, because the water is driven toward the Cuban shore, from which it escapes through the Straits of Florida, causing the strong current. A wind blowing across the stream does not change the position of the current. It simply throws the heated water by the break of the waves, and transports it by friction beyond the usual limits, but the current of the stream holds to its fixed position. The presence of gulf weed is in no way a sure indication of current, for it is carried more by the waves than by the current. A wind blowing across the stream may carry every particle of weed into the outside waters. It has been observed that gulf weed is found well up toward Nantucket Shoals. A long continued southerly wind will, by the break of the waves, transport the weed into this locality, which is 150 or 200 miles from the current of the stream.

The barometer is a fruitful source of abnormal variations in current in the Straits of Florida, but it is doubtful if much of its effect is experienced in the Atlantic. A high barometer in the Gulf of Mexico, accompanied by a lower barometer in the Atlantic, causes a greater outflow in the Straits, and with the reverse barometric conditions, a weaker flow. The first influence of the difference in pressure is felt on the sides of the stream, where the normal current is weakest. Ordinarily there is a neutral zone of current, beginning at "The Elbow" near Carysfort Reef lighthouse, and extending to Tortugas, in which the current is variable. With a high barometer in the gulf the current in this zone may be steadily eastward, and, if the same conditions are of long duration, the effect of the barometer may be felt throughout the stream. A navigator approaching Tortugas from the westward, and having a high barometer, may expect a favorable current skirting the Florida reefs, and consequently need not lay a course so far off shore in rounding the peninsula. Bound to the southward, and approaching the Straits of Florida with a low barometer in the Atlantic, the closer aboard the reefs are held the less will be the current found.

The above constitute the irregular and unusual variations of the Gulf Stream. The usual and normal current is subject to variations in velocity and somewhat also in direction, but these changes can be predicted with accuracy, and the position of the axis from off Havana to Hatteras is known. The average velocity is greatest at the axis, which is rarely in the middle of the current.

THE EARTHQUAKE IN TURKEY.

TURKEY has recently experienced some severe shocks of an earthquake, the center of action of which appears to be in the Mediterranean Sea. The first shock was felt on Tuesday, July 10, at twenty-five minutes past twelve noon, and caused many grave disasters. Several minarets of mosques, nearly 1,300 feet of wall adjoining the Adrianople gate, and the vaulted galleries of the grand bazar were destroyed, the number of victims being estimated at more than a thousand. Nearly all of the stone monuments were more or less broken. The buildings of the Sublime Porte, where were concentrated nearly all of the legations, were so much injured as to necessitate the removal from the offices to the courtyards. In fear of other shocks, nearly the whole population camped out in the cemeteries and public places, giving the city a very picturesque appearance.

The Princes' Islands were particularly injured. Among the numerous villas many were built of stone and were either destroyed or rendered uninhabitable. In the Khalki Island ruins are numerous. We present a view, for which we are indebted to L'Illustration, of the Orthodox Greek Church School of Theology. The building was very solidly constructed. Besides the school, the island contained three beautiful monasteries, well peopled with inmates; magnificent villas, and a naval school of the government. All these edifices are in the same lamentable condition. It is estimated that the total losses caused by the earthquake will foot up $40,000,000.

THE EARTHQUAKE IN TURKEY—THE RUINS OF THE THEOLOGICAL SCHOOL.

[THE LITERARY DIGEST.]

GREEK PAPYRI IN EGYPT.

THE search in the sands of Egypt for the buried records of the past has, within the last fifty years, and notably in the last decade, brought to light many Greek papyri pertaining to the period of Greek dominion in Egypt. These help very materially to complete our knowledge of the ancient Greek script as derived from Greek sources, the most ancient examples of Greek writing being those found in the papyrus rolls of Egypt in the second century B. C. But, according to Davis and Cobern's "History of Ancient Egypt in the Light of Recent Discoveries,"* Egypt itself furnishes Grecian records earlier than any which the Greeks have left us of themselves.

"The earliest Greek inscriptions," we read, "were written from right to left, as in the Semitic languages. Next came the method called boustrophedon, in which the written lines run alternately from right to left and from left to right, or vice versa. Lastly, writing from left to right became universal. In the most ancient tomb inscriptions of Melos and Thera we have the earliest form of writing. Boustrophedon was commonly used in the sixth century B. C. A notable example, however, is found in the famous Greek inscription at Abu Simbel, the earliest to which a date can be given. This inscription is the first absolutely firm standing ground in the history of the Greek alphabet, and consequently in the history of our own. It is cut in the leg of one of the colossal statues which guard the entrance of the Greek Temple, and records the exploration of the Nile up to the second cataract by certain Greek, Ionian and Carian mercenaries in the service of Psammetichus. The date is about 600 B. C. Besides this Greek inscription there are six Phœnician, nineteen Greek and three are in an unknown alphabet, which is supposed to be Carian. They were cut before what call Greek history had commenced, two hundred years before Herodotus, the father of history, had composed his work. As Taylor says, 'The history and importance of this work can hardly be exaggerated.' To the historian it is of interest as a confirmation of the account given by Herodotus of the employment of Ionian and Carian mercenaries; by the geographer it is prized as the earliest contemporary record of geographical exploration; for the philologist it conserves in an unimpeachable form a most primitive specimen of Ionic Greek. . . .

"A most interesting and valuable collection is upward of ten thousand Egyptian papyrus documents, which were discovered in the Fayoum, and purchased by the Archduke Rainer, of Austria, a few years ago. The collection is unique, and the documents, which are written in eleven different languages, have all been deciphered and arranged scientifically. They cover a period of 2,500 years, and furnish remarkable evidence as to the culture and public and private life of the

* Biblia Publishing Co., Meriden, Conn.

ancient Egyptians and other nations. These documents show that a flourishing trade in the manufacture of paper from linen rags existed six centuries before the process was known in Europe. Another interesting feature in the collection is a number of commercial letters, contracts, tax records, wills, tailors' bills, novels and even love letters, dating from 1200 B. C.

"Among the examples of cursive Greek writing taken from the Fayoum is the will of Demetrius, which is written in a remarkably fine hand, and may be classed as a good example of the official writing of the time, penned by a skillful and experienced registrar. The tax receipt is from a document of the thirteenth year of Ptolemy Philopator, recording the payment of a tax at Thebes.

"Although our knowledge of the Greeks from historical Greek sources may be said to begin with the first Olympiad, 776 years before the Christian era, yet our knowledge of the Greeks from sources external to Hellas dates from an infinitely earlier period, and it comes to us from Egypt. In a tablet carved on the cliffs of the valley of Hammamat, which leads from Coptos to the Red Sea, there exists to this day a record of the victories of Sankhara, last king of the XIth dynasty (circa B. C. 2500), in which he boasts that he had 'broken down the strength of the Hanebu.' Hanebu (which means 'the people of all shores') being the name by which the coast folk and islanders of the Ægean were designated, not only at that remote time, but as recently as the reigns of the Ptolemies. This is the earliest mention of the Greeks in the history of the world; we hear no more after this of the early Greeks in Egypt till they reappear as the Danai or Danæans, some twelve or thirteen hundred years later, in the reign of Tehuti-mes III. Two hundred years later we find on a colossal bass-relief group of Pharaoh Horemheb and his prisoners of war a profile of one woman of the Hanebu tribe; this is the earliest portrait of a Greek in the world. A hundred years later, as we have seen, the Greeks of the mainland, of the island, and of Asia Minor, came thronging in quick succession upon the stage of history."

[FROM A CORRESPONDENT OF THE SCIENTIFIC AMERICAN.]

PAESTUM, AMALFI, SORRENTO.

ONE day in Pompeii, the next at Paestum! If the impression of silence and desertion received in the long buried city is a profound one, even more profound is that made by the lonely temples at Paestum. We approached them by the railway from Salerno; for an hour we traversed a monotonous plain, now partly cultivated, but long a well known lurking place for malaria and brigands.

Pesto is the modern Italian name of the station at which we stop. A warm, dusty walk of ten minutes took us through the low arched gateway of the more than half fallen walls of what was once an important Grecian city called Poseidonia. It was founded, according to Strabo, by the Dorians, in the sixth century B. C. Whatever traces of the subjugation of the town by the Romans during the Pyrrhic wars, of its prosperity under the republic, when it was called Paestum, and of its nearly complete destruction by the Saracens, may now exist, all the traces of these revolutions are buried beneath a scraggly growth of grass and low bushes.

The Grecian temples only remain to speak with majestic voice of the faith and architectural skill of their builders.

The temple of Neptune is the central and best preserved of the three; the Basilica is near it on the south, so that approaching as we did, our first impression of the grandeur and symmetry of the structures was received from these. All the temples are built of yellow travertine. Slight remaining traces of stucco show that the irregularities of the stone were once covered by it, and this, we may suppose, was adorned, according to the custom of the Greeks, with color and reliefs. The present rich golden brown of the travertine columns is very beautiful. Standing alone on this wide, low plain, the height and extent of the ruins is sure to be at first underestimated. "Those Greeks must have had big legs," was the comment of our guide as we climbed the three high steps which lead to the temple of Neptune. These steps, as well as the broad platform at the entrance, are made of large blocks of gray lava. In the crevices between these blocks little fig trees have found a foothold. The Doric columns which rise above the platform number 6 on the two shorter sides and 12 on the longer sides; they are about 27 feet high. The architrave and the frieze are about 12 feet high and the gable is nearly 9. Within this outer row of columns stands another, which defined the cella; these are 22 feet high and 6 in diameter. Upon their architrave rose a second row of columns of about half their size; of these, three remain on one side and four on the other. These upper columns formed the direct support of the roof of the peristyle and the side aisles of the cella, but not a fragment of the roof remains in place. It is not known positively where the image of the god stood.

Covered as the columns were to be, no attention was paid to the regularity of the length of the blocks of travertine of which they are formed, but the symmetry of the whole column is perfect.

The Basilica is a little smaller than the temple of Neptune, the inner space inclosed by its columns being 79½ feet wide by 180 feet long. The outer columns are standing, but the cella is a complete ruin. Two fallen capitals, lying each with its abacus still attached, are in such position that one can stand beside them, and there one realizes for the first time how large those are which are still in place, and how lofty and massive are the columns which they surmount.

The third and smallest temple is Ceres; it is a short distance north of the others. The 34 columns of the peristyle are all standing; they are about 20 feet high and 4 feet in diameter at the base. Only a part of the front gable remains, and but four of the columns of the porch.

Many large blocks of stone lie within and about all the temples. We know that whole interior columns have been carried away to be used in other buildings. Those which remain show many evidences that time and animal life and human marauders have combined to make the temples shapeless ruins. There is inspiration in the fact that they have withstood such long-continued attacks of foes so resistless.

Let us hope that the profits from visitors may be sufficient to make it an object for the Italian government to protect the lonely, solemn structures from further decay. Slight restoration and iron braces are evidence of effort in this direction.

AMALFI

The little plants which have found lodgment in crevices of capitals, along the pediments, and even in the cavities of the columns, lend softness and beauty and interest to the temples. Mourning brides are blossoming in the cella of the largest one, as luxuriantly as if carefully tended by human care. Lizards glide about in the sunshine, and now and then a snake proves that he has found a hiding place in a stately column.

Two gateways and low, broken walls are almost the only other visible remains of this once important city. When, some time, archæologists excavate the land between the temples and the walls, they will very likely find much that throws light upon both Grecian and Roman life. Meantime, the traveler has nowhere, except at Athens, so good an opportunity to study ancient Greek architecture.

We saw the temples in the morning. It is said that at sunset and by moonlight they have a peculiar and indescribable beauty, but the danger from fever at these hours is so serious that cautious people forego the pleasure.

Returning by train to Salerno, we there took a carriage for Amalfi over the wonderful highway which, when completed next October, will extend to Sorrento, a distance of nearly forty miles. One hardly knows which more to admire, the skill of the engineers who have built the road or the scenery which it offers, at every turn. The mountains rise from the edge of the Bay of Salerno, and they have been blasted away for a space wide enough for the highway, and its outer side is guarded by a wall about three feet high. I cannot hope to do more than faintly to suggest the loveliness of the changing views we had on that charming July afternoon.

Below us, on the left, lay the blue bay, quiet, shimmering, with a little fleet of fishing boats fitted with lateen sails dotting its surface. On the right tower the mountains; the cut-away walls are a most interesting study in stratification; in places it requires no imagination to believe that the limestone was deposited in the form of sediment, as the strata are absolutely horizontal; again they are folded and tilted; the cleavage is distinct almost anywhere. The color of

THE TEMPLE OF NEPTUNE, PAESTUM.

the rock varies from almost chalky whiteness to blue. On these bare, cleft walls bunches of the daintiest star-shaped blue flowers grow. They seem to have not a morsel of earth under them, and they must get their moisture as it passes them, but they could not be prettier. Above the cut walls the mountain sides are terraced, and below the road also, where it is possible, to the very water's edge, they are terraced; for miles we drive, with vineyards above and below us growing on this what would seem hopeless ground. The sunshine was there, and men have made these fertile shelves, where it seems hardly possible they could stand. The vineyards give place within a few miles to lemon groves planted in the same way, the trees supported on frames through which the large lemons hang.

High above the road the village of Raito clings to the mountain side; Cittara is where the territory of the little republic of Amalfi once began. All along, on high points jutting into the bay, are lonely, picturesque square towers, called Saracenic towers, though it is not known, I believe, who built them. They are all after the same fashion, square, wider at the top than below, too small to have served for anything except watch towers, but most picturesque. The road winds up and down and around the rocky walls, now with olive and fig and carob trees climbing their sides, now under cliffs that tower bold and bare above all vegetation; then the lemon terraces are rich and abundant as we near the two quaint villages of Majori and Minori. In the latter are the tombs of the princes of Amalfi. Atrani, with its picturesque ruins of a castle and convent, is but ten minutes' drive from Amalfi. As the sun was almost setting, we wound down to the water's edge into this queer little town with its strange history. It was founded in the fourth century by Constantine the Great. At one time it was rich and powerful, with republican institutions; its rulers were princes chosen by vote for life, and called, at first, consuls, then earls or counts. In the time of its greatest power it had 50,000 inhabitants. It had misfortunes at the hands of various conquerors, but its worst calamity came in the thirteenth century, when, during an earthquake, a large part of the town sank into the sea.

What is left is actually clinging to the mountain side. One little square level spot is bricked over, and there are two narrow little strips each side of it, where the boats are drawn up—these are the only places where there is level standing room. From these the cramped, crooked streets wind up the mountain side; in the market square stands a fountain with a statue of Andrew, the patron saint of Amalfi. Just opposite a flight of broad steps leads up to the Cathedral of St. Andrew. Some of the columns in the portico and mosaics in the choir were brought from Paestum, and the bronze doors were cast in Constantinople.

Passing out of the little square, we wind higher still through a narrow lava-paved street, under old arches, beside what seems to be a succession of locks, each with a little water in it. These little boxes of water are, in fact, the power for the paper and flour mills built along them at different levels. The highest mill uses the mountain stream when first it has gathered force and volume enough to turn a wheel; then the water falls to where another mill has been fastened to the rocks, and turns there another wheel; below it does the same work. There is authority for saying that paper was invented in Amalfi; certain it is that a considerable number of very old mills are now busy. I visited one. The foreman boasted that, though the building had stood perhaps a thousand years, some of his machinery is modern. It was not that part which most interested me, but it was the primitive apparatus with which the old fish nets, twine, etc., are reduced to pulp. The water falls over a small, clumsy wooden wheel which is connected with mashers set over wooden tubs. These mashers consist of three square hand-hewn sticks of timber set on pivots. To the end which is over the tub other square hewn sticks, perhaps 16 inches long, are fastened at right angles. In the low rock-bound room the full force of the water was turned on to the wheel that I might see all the mashers at work in the four tubs. They pounded well. In the next room, smaller still, I saw the pulp reduced, bleached and further dissolved. On the floor below the pulp is caught on modern cylinders, dried on canvas, and is taken off in little sheets. It is a very ordinary, unsized paper, but it is put up in attractive looking packages. As we came down from the mill we had a glimpse into a room where rags are stored and were being handled by women. There are rags and rags. These were smaller and dirtier and more worthless looking than anything I ever saw except the bits of old nets at the mill above. This is the place to learn that, no matter how old anything is, it may still be utilized.

Poets and painters have found rich themes for pen and brush in Amalfi; perhaps it is because they are most here in winter and spring, when the softness of the air throws a spell upon them, that they seem to feel only the picturesqueness of the spot and its people. Surely in the summer time the pathetic side of life makes a strong appeal. The girls in Amalfi are famous for their beauty; they have rich complexions and thick, black hair. But what toilsome days they have! We meet them bringing down enormous baskets of lemons from the high terraces to the boats on the shore. They carry the baskets, not on the top, but the back of the head, which must be bent far forward. With this load, in this painful posture, they come down the long, rough, stone steps with bare feet! There are places where they let the load slide down their backs, resting it against a support, while they wipe their flushed faces. A foot bound up in rags tells the story of cruel hurt on the sharp stones. Our Italian guide tells us that the girls like it, that they would not wear shoes; but he cannot make us believe that the bent women we meet, who look seventy and are forty, he says, would not be glad to be erect and elastic in middle life. The young girls do all the lemon carrying, but the women are loading great cases of macaroni and packages of paper, and are toiling up the hill with long wine kegs, all in the same painful way.

The oldest women are sitting in the doorways spinning flax for the nets, and both men and women are making the seines. The great iron pots on the street below our hotel windows are used to dye them in. Men are standing in deep water to wash their nets after the catch has been drawn ashore, and men and women are spreading out others' to dry. The fishing industry is one of the largest; tunny fish of great size are packed in oil for exportation. The level, bricked square, where last night the children were playing and priests were taking their evening turn, is this morning covered with piles of ground corn, which is to be made into macaroni, and with macaroni itself for the drying process. There are said to be only 7,000 inhabitants now, and we must have seen nearly all of them in the streets; all, except the very young children, are intent upon the struggle which mere existence means. There are many beggars, and who can wonder?

The place where the most picturesque view of the bay and the town and the heights above is gained, the point where it would seem the most matter-of-fact person must grow enthusiastic, is the old Capuchin Convent, for the last thirty-five years used as a winter hotel.

It is not an easy climb, but the view is rewarding at each new zigzag. We were graciously received by "Donna Louisa," who, with her brother, our host in the "Albergo dei Cappuccini," owns the place. She was superintending the preparations for the guests whom the autumn is sure to bring.

The monks' garden has grapevines for its cover, and comfortable seats invite one to linger among the roses and geraniums, the jasmines and oleanders, which are masses of color and fragrance. The view from between the white pillars is simply entrancing. Above this "Donna Louisa" has her fruit garden, to which she invited us. There we were under orange and lemon trees, loaded with ripe fruit of delicious flavor. The old monastery, founded in the thirteenth century, has been fitted up with modern comforts, with as few changes as possible. The cells, with their little balconies, make cozy bedrooms. The cloisters extend from the house to a grotto, to which pictures give an exaggerated idea. In these a crucifix, crosses, pictures, and figures of saints remain—the incentives to devotion which the old monks had. They are less suggestive to the modern eye than are the bay below, the grand tower-crowned heights above, and the busy, half hidden village.

It is from the convent garden, which at this season is by far the most attractive place about the monastery, that Longfellow, in his poem "Amalfi," makes the monk look down upon the marvelous picture.

I have said that the highway from Salerno to Sorrento is not yet finished; it is a part of the distance between Amalfi and Prajano which remains to be completed. So we left Amalfi in a rowboat with four men, each with an oar; the sky was cloud-flecked enough to be beautiful, the air delightful, the water of the bay green on our right, where the reflection from the banks fell upon it, blue on the left. We followed the curve of the shore in the calmer waters, every turn giving a new picture full of charm, and in an hour had made the eight miles to Prajano, a tiny fishing village. We were landed on an outjutting rock, climbed a stone staircase to the level of the road, and there found a carriage waiting to take us to Sorrento. It is this part of the drive which is considered the most beautiful in Europe. Of its grandeur I can give no idea, but surely no one who has passed over it can resist the temptation to speak of some of its charms. For about fifteen miles it lies above the bay of Salerno, following the outline of the mountains. They are far more rugged than north of Amalfi, and little attempt has been made to cultivate their sides. There are deep, dark gorges walled in by masses of rock which reach into the clouds; waterfalls give a thread of silver here and heighten the beauty of the red-stained rock a little further on. When we reach the highest point in the road we are between 400 and 500 feet above the sea; behind us we have left a mass of rock with a hole through it—a great natural window. We have left Positana also, a more than half depopulated village, once flourishing and standing among olive and fig groves on the terraces. Cacti, oranges and pomegranates grow in and about it still, but the people have largely abandoned the place. There are many grottoes all along the road; a large one has been converted into a house by setting a wall with a door and windows in front of it. A small one close by was more easily turned into a stable.

More curious to my eyes than anything else are the stalagmites which are forming all along the route where the rain is dissolving the limestone and where in the process of time other grottoes will be. The engineer of this wonderful road has not neglected opportunities to beautify it; at one place, where he had to build a bridge along the edge of the cliffs, he left a great sentinel-like mass of rock at each end. Toward sunset, after we had passed some needle-like islands, we turned to find that on the mountains we had left behind two strata of clouds were resting, tinged with red, and the softer light was on the water. The road leaves the coast for a time and we drive among olive trees with clumps of fragrant white myrtle at their feet. There are here large oak and walnut trees, and for some distance a hedge of cactus takes the place of a wall. We pass vineyards now and little patches of grain. Suddenly we find we have reached the top of the narrow peninsula, and before us is the crescent bay of Naples, and the side of Vesuvius, which was hidden from the north, is now in full view. From this point we drive along between highly cultivated hillsides; there are orange and lemon groves loaded with fruit, very large fig trees, vines with clusters of grapes already large, and high above them the blue green of the olive trees fades into the mist that hangs now on the upper heights. We wind along in the fading light through the villages of Meta, Carotto and Piano, and at eight o'clock are in Sorrento. It is on a high cliff, with its beautiful bay below and the island of Capri only an hour away. From our hotel we look across to Naples and see the flame light up the pile of vapor above Vesuvius. Sorrento is especially attractive in summer, because it faces the north; it is a sacred place to some, because it was the early home of the poet Tasso. A. D.

Sorrento, July, 1894.

IT is alleged that the use of pince-nez in the place of spectacles is apt to cause cancer. A gentleman recently died of this disease, brought about by pressure on the bridge of the nose.

[FROM THE BUILDER, LONDON.]

PROGRESS OF THE EXCAVATIONS AT DELPHI.

DISCOVERIES at Delphi during the past spring and early summer have followed each other thick and fast. The present seems a favorable moment for presenting a brief summary of the work already done, with a view to clearing the field for the better understanding of the fresh campaign shortly to be begun in the autumn. There is no question that the results, so far, have exceeded expectations. The precipitous site of Delphi, and the certainty that it had been repeatedly pillaged, led to gloomy forebodings that, save for inscriptions, little of value would be found. But fate has been unusually kind, and that in the matter of sculptures, where least was expected. It is with these sculptures that we propose to begin our résumé.

First and foremost, unique indeed among archaic sculpture, stands the frieze from the Treasury House of the Siphnians. The Island of Siphnos has sprung into sudden archæological fame. Pausanias (x., 11, 2) mentions the Treasury, but not the frieze. He tells how the Siphnians had productive gold mines, and how in accordance with an oracle they built the Treasury and offered a tithe of their revenue from the mines to the god; how later they omitted the tribute, and the sea broke in and destroyed the mines. The frieze discovered is of Parian marble, and is in an excellent state of preservation. It is executed with extraordinary minuteness and delicacy; certainly only a wealthy community with gold to spare like the Siphnians could have afforded a work involving such an amazing amount of labor. Dr. Baumeister, in noting his impressions, said that it reminded him of an archaic vase of the finest and most delicate style translated into stone. From his account (Berliner Philologische Wochenschrift, 1894, No. 27) we borrow the following details: On one side is depicted a fight of gods and giants; the giants are represented as usual in black figure vase paintings as armed men, the gods are in many cases supported by their attributive animals, which at this early date is somewhat surprising. The center place is occupied by Kybele in a chariot drawn by lions; one of the lions has fallen upon a giant and is tearing him to pieces.

The shields of the various combatants are seen mostly from the inside, and are sunk in the ground of the frieze; they bear many traces of red coloring; whereas the defensive weapons, as well as bridles, trappings and the like, are worked in relief, and so delicately that in many cases they are broken away; some were put in in bronze.

On a second side is represented an assembly of the gods. Ares, armed, is seated at one end, Leto and Artemis are caressing a youth who turns toward them, and who is presumably Apollo. The fragment with Zeus has not yet been found. Athene wears her ægis, which it is interesting from the mythological point of view to know is represented as a skin. She and Dionysos both sit upon splendidly carved seats. The arm of the chair of Dionysos rests on a satyr and a mænad, carved with a minuteness that can only be compared to ivory technique, and which therefore are only partially preserved. From the account of this frieze we may conjecture that the subject is not a mere conclave of the gods, but an assembly for the special purpose of receiving Apollo among the Olympians—the scene described in the Homeric legend, and which, according to Dr. Dummler, appears on the Brygos vase in the Louvre. Such a scene would, of course, be most appropriate at Delphi.

A third series of slabs is in subject less interesting. It represents a Homeric combat over a fallen warrior; the scene is bounded by chariots with charioteers. The last series is less clear in meaning. It represents a scene within a house; female slaves are depicted standing in evident alarm near some κῆβοι. This is at one end of the composition. It is confidently expected that in the course of the excavations the whole series of slabs will be completed, and we shall then have a monument of very peculiar technique and of great importance qua subject.

The remaining sculptures, to which, from time to time, we have called attention, may be more briefly noted. The metopes of the Treasury of the Athenians are only second in interest to the Siphnian frieze. The building, it will be remembered, is dated exactly by an inscription stating that it was set up as a votive offering after the battle of Marathon; so that here we have a definite fixed point in the chronology of Greek sculpture—a standard by which to judge and date other monuments. The subjects represented in the metopes are deeds of Herakles and of Theseus and Amazon contests. It is specially fortunate that a monument so securely dated should be decorated with these subjects, which are such frequently recurring types, as it makes comparison the more easy. We again quote Dr. Baumeister as to the style of these metopes. The fetters of archaism are by no means thrown off; in some points the figures resemble the Ægina marbles; there is still great difficulty in expressing any but the simplest attitudes. In the Herakles metope, e. g., in which the hero is represented as overcoming the Kerynean stag, he is supposed to be kneeling on the creature, but at the first glance he seems to be lying backward, somewhat in the attitude of the familiar drunken Faun of Munich; the ancient artist could not make up his mind to completely forego the full-face attitude of the body.

From the great Temple of Apollo, so far, only one fragment has been discovered, and that is the colossal head of a horse. This probably comes from the Eastern pediment, in which was represented Apollo between Leto and Artemis, in the angle, the setting sun. In all probability the horse belongs to the sun's chariot. From the western pediment, in which Dionysos and his Thyiades were represented, no fragment has so far been found, or at least identified, but as the excavators are only just now actually coming to the great temple this is not surprising.

It is uncertain to what building a small pediment belongs, made out of one slab. On it is represented that popular Delphic subject, the contest between Herakles and Apollo for the tripod. The style of the design is very stiff and archaic. The building, probably a treasure house, must have been a very small one. Gathered together in a temporary museum are a number of other more or less fragmentary sculptures,

and noticeable among them is the head of the Sphinx dedicated by the Naxians. The colossal body still lies where it was found on the terrace between the great temple and the polygonal wall. It is a noticeable point in the head that the "archaic smile" still lingers about the corners of the lower lip, whereas the upper lip is quite expressionless. Another colossal statue (of Apollo) with an inscription must be noted in passing. It is by an Argive sculptor, and is of archaic style. From a gigantomachia there remains a very remarkable fragment—the head of a wounded combatant worked in high relief.

An arrow has pierced the left eye, and the point protrudes near the right ear. The expression of intense suffering is noticeable, the eye (the face is in profile) is staring wide open, the forehead and upper part of the nose wrinkled in folds, the mouth open and the teeth clenched; the hair stands on end, looking almost like a halo of flame.

We pass next to topographical and architectural discoveries. The modern village of Kastri has, as is well known, been completely removed. It is perhaps not so well known that it has only been moved away about a hundred paces in the direction of the village of Chryso and there solidly rebuilt. The peasants have gained substantially; but there is this archæological disadvantage that the western necropolis of ancient Delphi, with its innumerable rock-tombs, has been sacrificed in considerable part to the new modern village. The modern Kastriote has no archæological compunction, and is not restrained from breaking up these rock-tombs wherever they form a convenient quarry for building stone.

The plan of the excavations has been to begin on the lower ground and work upward. Several rails have been laid down for trucks to transport away the debris. The work is carried on under the immediate supervision of M. Homolle. There is at present no architect in charge, but there is, of course, an engineer to supervise the practical operation of the works. The Wochenschrift complains of this omission, and states that sufficient attention is not paid to the recording of the exact position in which monuments are discovered. Comparison, much to the disadvantage of Delphi, is drawn with the method of work at Olympia. It is only fair, however, to remember that German criticism of French work is not likely to err on the side of partiality. Moreover, the conditions at Delphi and Olympia are widely different.

At Olympia we have a flat plain with no important differences in elevation—an ideal field for excavation. The precipitous position of Delphi makes it a most difficult site for systematic excavation, and, in the case of vases and inscribed stones, obviously already not in situ, they often must be moved, and the position where they were found is of comparatively little importance. The French are certainly not, as a school, so strong in matters of topography as the Germans, but with the critical eyes of Europe fixed upon them, it is scarcely likely that any serious oversight will be possible. Moreover, from other sources we learn that an exact register is kept of the precise place where each object is found and the condition of its finding.

Entering the precinct, as Pausanias did, from the east, it is interesting to note that the excavations have in the main confirmed Pomtow's acute conjectures as to the lie and direction of the Sacred Way. The Arcadian inscription mentioned by him is not visible now, but the brazen bull by Theopropos, the monument which Pausanias mentions as standing at the entrance, has yielded its basis with the inscription. Unfortunately this is one of the instances where a basis is not in situ. The bull, it will be remembered, was a votive offering to Poseidon from the Coreyrans. Tradition said that a bull in Coreyra used to leave the rest of the herd and go down to the sea bellowing. As this happened daily, the herdsman went down to the sea to find out the reason, and noticed a shoal of tunny-fish. The people of Coreyra had great difficulty in catching as many of the fish as they wanted. They sent messengers for instructions to Delphi. The oracle bade them sacrifice the bull to Poseidon, which certainly seemed hard on their benefactor. It was done, however, and the tunny-fish caught. The bronze bull at Delphi represented the tithe of the take. A little further along the Sacred Way two semicircular bases stand, one on either side of the road. On these must have stood some of the many votive statues enumerated at this point by Pausanias. The bases discovered are almost countless; they are far more numerous, more architecturally varied, and some of them larger in size than those found at Olympia. The few that remain in situ are of course invaluable as topographical fixed points. The Sacred Way itself is paved with large slabs of stone, and these are indented with grooves to facilitate the steep ascent.

The ascent is straightforward for a little distance, the bases of votive offerings being ranged on either side; but before the first turn of the road and mostly to the left hand lie the foundations of the various treasure houses. Portions of the walls of these remain to a considerable height. The Sacred Way continues the ascent to the south of the polygonal wall with the long-known stoa of the Athenians, but a branch road goes to the northwest round the polygonal wall.

Close to this point lies a group of cleft rock left quite unworked on the inner sides. This rock group has an important cultus significance; it is the πετρα αντίχουσα ὑπὲρ τῆς νῆς, which Pausanias (x., 12-1) mentions as the place where the Hierophile in old times chanted her oracles, she who was called the Sibyl; she was the first woman who uttered oracles. The Sacred Way next turns round the east corner of the polygonal wall to the north, and passes by a large complex of walls, the purport of which is somewhat problematic. It lies to the west of the large temple. Dr. Baumeister conjectures that it may be the great altar—its position fronting the east end of the temple would be appropriate. The Sacred Way passing this supposed altar on the east side mounts steeply up and takes a turn necessitated by the great temple. At this point the excavations are now in full progress, and it is, therefore, too early to report on results. Great drums of columns lie about in all directions, and some uncompleted capitals. The ground plan cannot yet be determined with certainty. The railway track line leads, according to the account in the Wochenschrift, right across the temple foundation, which seems undesirable.

We may remind our readers that in vol. xiv. of the Hellenic Journal Dr. Middleton has a paper on the "Temple of Apollo at Delphi," bringing together all the information possible before the excavations. It will be interesting to note how far his conjectural plan of the temple is borne out by facts. M. Homolle, the director of the French School, is most hospitable and kind in facilitating the inspection of all antiquities discovered, but, naturally, no photographs, measurements, sketches, etc., are allowed. It is proposed to publish the results as soon as possible after discovery, in a special work to appear in installments. The mass of materials is too great for publication in the ordinary bulletin of the school. The first issue will be looked for with interest, and we may hope it will contain the remarkable Siphnos frieze.

ROMAN REMAINS AT BATH, ENGLAND.

ACCORDING to the London Daily Graphic, the good intentions of the corporation of Bath in inclosing and erecting a roof over the ancient Roman bath, which is one of the principal glories of their interesting city, are likely to be received with but scant gratitude on account of the apparent vandalism involved in the proceeding. The ancient outer wall of the building inclosed first a broad level platform, from which stone steps led down into the pool supplied by the warm springs, whose cures made Bath so famous a place of resort in the last century. Of course, the Roman building was covered with a roof—the English climate would not permit of a bath open to the sky; but this covering had gone many centuries ago. It is now proposed, as a measure of preservation, to erect piers on the platform on either side of the pool, the piers being connected by arches and supporting a new roof. Perhaps atmospheric conditions render some such precaution necessary—although the ruins have been exposed some time without any very noticeable effect having been produced upon them; but what is particularly objectionable in the scheme is that the new building will not correspond with the old one, the new inclosure being within and not upon the lines of the ancient wall, and so destroying the proportions of the building. The work will also necessitate very serious disturbance of portions of the ancient remains. These are proposals which antiquarians will hardly allow to pass unchallenged.

THE ROMAN REMAINS AT BATH, ENGLAND.

A PROLONGED SUNSPOT MINIMUM.

By E. WALTER MAUNDER, Hon. Sec. R.A.S., Physical Superintendent Royal Observatory, Greenwich.

THE progress of the sunspot cycle has been on the whole so regular since Schwabe first demonstrated its existence, that we might easily assume it to be a fundamental law of solar change. Maximum has succeeded maximum, and minimum minimum, at an interval in each case so closely approaching eleven years that we might confidently expect the present great activity to begin to decline within the next year or so, and to reach a minimum about the end of the century, as a year or two ago we were looking for some such a development of spots as we are beholding now. Some of the theories adopted to account for the cycle, indeed, assume it to have on the whole an unfailing regularity. The secret of the great solar outbursts has, for example, been ascribed to the return of Jupiter to perihelion. If this theory be adopted, then, since that return is regular, punctual, and unfailing, so ought its effect to be, and it should be as impossible for the sun to intermit two or three of its cycles as for Jupiter to wander from his orbit.

The sequence of maximum and minimum has, in fact, been unfailing during the present century. Within the experience of living observers the appointed time has never come round without the appearance of spots, vast in area, violent in change, and many in number; and one might be forgiven for inferring that as it has been for so long, it must always be, and must always have been. And yet there is the strongest reason to believe that for something like half a century, if not indeed for the full term of "threescore years and ten" allotted as the span of human life, the ordinary solar cycle was once interrupted, and one long period of almost unbroken quiescence prevailed.

If we turn back to the earliest volumes of Philosophical Transactions of the Royal Society, we find the first notice of a sunspot occurs in No. 74, dated August 14, 1671, where it is stated that "at Paris the Excellent Signior Cassini hath lately detected again Spots in the Sun, of which none have been seen these many years that we know of." So novel, indeed, was the observation felt to be, that Oldenburg, the secretary of the Royal Society, and editor of the Transactions, evidently considered it due to those interested in science to give an account of the last observations of the kind that had been secured in England. These had been made "by our Noble Philosopher, Mr. Boyl," in the months of April and May, 1660; that is to say, more than eleven years before.

Cassini's observations reached London in due course and appear in the next number of the Transactions, which bears the date September 18, 1671. His first words, which have been "English't out of the French," run as follows, and also point to the great rarity of sunspots at that period:

"It is now about twenty years since that Astronomers have not seen any considerable Spots in the Sun, though before that time, since the Invention of Telescopes, they have from time to time observed them. The Sun appeared all that while with an entire brightness, and Signor Cassini saw him so the ninth of this month of August.

"But the Eleventh of the same, about six o'clock at night, being furnisht only with a three foot glass, he remarked in the Sun's disque Two Spots very dark, distant from his apparent Center about the third part of his Semi-diameter."

Then follows a description of the appearances of the spots and of their positions on the three days of observation, August 11, 12 and 13, but this, though so interesting to the astronomers of the time, need not claim our attention. The point of wonder to them was that any spots at all should be seen; the point of wonder to us is that they were not common and familiar objects.

This group was observed at its return in the next rotation, among others by Dr. Hooke, the celebrated professor of geometry at Gresham College. But after it had passed off the disk the second time the sun appears to have remained spot-free until November in the following year, when Le Monnier records the passage of a group. Then again a blank interval follows until in July and August, 1676, a fresh outburst occurred which drew the attention of several astronomers, our own Flamsteed and Halley in England, as well as Cassini at Paris. Later in the same year Cassini records another group which was seen during four rotations, and of this he says: "This is the third spot which has appeared in this year 1676, in which they have been more frequent than they have been during the twenty years preceding." A group is recorded in April, 1677, two or three in 1678. In connection with one of these appearing toward the end of May, Cassini remarks that the spot "was quite close to the limb in the middle of a region brighter than the rest of the surface of the sun, and was followed by a great number of other little markings of a like character. . . . These have been called Faculæ by Scheiner, who has often observed them. They have already appeared once this year, after the dissipation of the spots which appeared from the 25th of February to the 4th of March."

In 1680, spots were seen in May, June and August, the group of May being a large one. In 1681, Siverus and Vagetius record spots in May and June. Then we come to 1684, when Flamsteed again has given us an observation of a spot on the sun's disk. "These appearances," he adds, "however frequent in the days of Scheiner and Galileo, have been so rare of late that this is the only one I have seen in his face since December, 1676."

This year, 1684, seems to have shown several spot-groups; 1686, two or three; 1687, none; for Cassini states in 1688 that "no matter what care he had taken to observe the sun when the sky was clear, he had not been able, since the year 1686, to detect any spot upon it until the 12th of May last." A few spots were seen in 1688 and 1689; then nearly six years passed

without any being observed, for the next record is one of a great spot in May, 1695. Again a barren period set in, and it is not until the eighteenth century was about to dawn that we find any further observations. De la Hire and Cassini observed a great spot in November, 1700; the spot of May, 1695, was thus the only one recorded in a period of eleven years.

This long-continued dearth was now approaching its close. The Rev. William Derham, who made a special study of the sun at Upminster, has given a record of his observations in No. 330 of the Philosophical Transactions, and in most months of 1704 and 1705 one or more spots were seen. More remarkable still, in January, 1704, and again in October, 1705, the appearance of two separate groups on the sun at the same time was signalized. "Since the observations of Scheiner," is the comment of the Histoire de l'Academie, "made sixty years ago, one has scarcely ever seen two groups of spots on the sun at the same time." The wonder was, however, destined to become more common, for in 1707 it happened twice.

A new decline then set in. Derham's observation of a spot in January, 1710, and De la Hire's of another in October of the same year, appear to be the last for a considerable time, the sun being spot-free, according to Wurzelbauer, from the time of the disappearance of the last-mentioned group, October 29, 1710, till May 19, 1713. But a few years later quite a different state of things prevailed, and in 1716 the Histoire records: "This year has had still more spots than the preceding, and perhaps no other year has had so many. There have been twenty-one different appearances of them, counting only as a single appearance that of several different spots at a time. Only the months of February, March, October and December have been free from them. In the other months the appearances closely followed each other, and to compensate several lasted only a short time. The phenomenon of two different spots at the same time has entirely ceased to be rare. It has been seen on April 20 and 21, May 11, July 26; but that which is yet more remarkable, from August 30 to September 3 eight different and totally distinct groups of spots have been seen in different regions of the sun. No diminution in the brightness of the sun has, however, been perceived."

With this great increase in activity, which rose to a yet more decided maximum in 1718, the long period of depression came to an end. It is not so certain when it commenced. A maximum was due, according to the ordinary course of the eleven years period, in 1649, but there are very few observations of spots at the time, and not a few notices in the years from 1648 to 1660 that the sun was spot-free.

Perhaps the most striking evidence we have of the reality of this prolonged dearth lies in the evident excitement and interest which the occasional appearance of a spot called forth. Picard, who independently discovered Cassini's spot of 1671, when at sea near the Texel, declares that he "was so much the better pleased at discovering it, since it was ten whole years since he had seen one, no matter how great the care which he had taken from time to time to watch for them." Cassini, again and again, and Flamsteed also, announce the time when a spot may be expected to return, for the benefit of their brother astronomers, since it is a "phenomenon which it is not in our power to see whenever we wish." And the references to the more prolific times of Scheiner and Galileo are not infrequent.

On the whole, then, it appears probable that after the maximum of 1639-40 had fairly died out—that is, after about 1643—a prolonged period of almost entire absence of spots set in, a period broken only by the very rare apparition of a single spot now and then, and by the feeble revival of 1708-7, and which cannot be considered to have terminated until the setting in of the maximum of 1715-30. For all this period, or at any rate from 1655 to 1703, the ordinary progress of the solar cycle appears to have been in abeyance, and we can hardly speak of it but as an extraordinary and immensely prolonged minimum.

And yet, just as in a deeply inundated country the loftiest objects will still raise their heads above the flood, and a spire here, a hill, a tower, a tree there, enable one to trace out the configuration of the submerged champaign, so the few solitary spots observed seem to mark out the crests of a sunken spot-curve. 1660, 1671, 1684, 1695, 1705, the years most notable for such stray spots as were observed, correspond as nearly as we can expect to the theoretical dates of maximum.

It may be objected, perhaps, that bearing in mind the feeble instruments of those days, and the paucity of observers, it may well have happened that many spots may have passed unnoticed during the seventy years in question. But no great instrumental power is needed to detect the presence of a sunspot, and indeed a single diligent observer using his unassisted sight during the last twenty-five years would have compiled a far heavier record than all the astronomers of Europe have been able to hand down to us for the years between 1643 and 1715. Besides, telescopes were considerably more powerful than those in use earlier in the century. Yet we have but to refer to the works of Galileo, or to the plates, drawn with such evident care and fidelity, which adorn Scheiner's huge "Ro-a Ursina," to be assured that outbursts such as the sun presented in 1625-27 could never have passed unnoticed fifty years later.

Nor were the observers few. In England there were Flamsteed, Halley, Hooke, Gray, Derham; in Holland, Huyghens; in Germany, Vogelius, Siverus, Vagetius, Wurzelbauer; in France, Picard, De la Hire, Maraldi, and above all Cassini. Indeed Derham, writing in 1711, well anticipates this objection. "There are," he says, "doubtless great intervals sometimes when the sun is free, as between the years 1660 and 1671, 1676, and 1684. In which time Spots could hardly escape the sight of so many curious Observers of the Sun, as were then perpetually peeping upon him with their Telescopes in England, France, Germany, Italy, and all the World over; whatever might be before, from Scheiner's time." And the fact that a new spot was apt to be independently discovered by more than one observer shows that the watch was carefully kept. The sentinels were neither few nor inefficient, nor can many stranger spots have eluded their vigilance, except under the cover of continued cloud.

A few, perhaps, did pass unnoticed. The watchful Cassini thus missed the spot of January 22, 1710, which Derham detected. Flamsteed let slip several which Cassini observed, but after making the utmost allowance for imperfection in the record there can be no doubt that the seventy years in question were barren of spots to a degree to which there has been nothing to correspond since.

The unanimity with which, when the earlier days of revival had come, all observers speak of the greater frequency of spots as quite a new experience, is irrefragable evidence that the change was a very real one. The "Histoire de l'Academie," calling attention to this very change, states: "Since 1695, for example, up to 1700, none were seen. Since 1700, our histories have been full of them up to 1710, when only one was seen, and it would appear that they were drawing to an end." Derham, in 1711, refers to 1690-99 as a time "when Spots on the Sun were more rare than for these three or four years past they have been," and yet his record for these more prolific years, when compared with those of the present century, shows that 1704 and 1705, though so abnormally active as compared with the sixty years that had preceded them, were little (if any) richer than the years of an ordinary minimum. We expect now about sixty per cent. of the days of such a year to be free from spots; for the years immediately preceding or following minimum say about twenty-five per cent. Near maximum we expect to get five or six years running without a single instance of the sun being spot-free. And so far from two groups at once on the sun being a rarity, we look to have a dozen on the average, a number which may rise to seventeen or eighteen on occasion, as it did in December last; while a maximum year, like those of 1892 or 1893, will show three or four hundred distinct spot groups, instead of the twenty-one which were considered so extraordinary a record in 1716. It would be quite impossible in these days for a Wurzelbauer, however small his instrument, to observe "daily" for five years without seeing a spot, or for a Cassini or Picard to do the same "from time to time" over a period of ten years, with a like barren result.

This long continued solar rest suggests many questions to which we can find no reply. How we regret the absence of magnetic records, and how valuable would be a few of those ponderous volumes of rainfall and temperature that, when published by modern observatories and in these days, we are apt to look upon with scorn. The connection between the magnetic and sunspot curves is unmistakable to-day. Did terrestrial magnetism sympathize then with the long solar calm? Theorists have traced all kinds of connections between the solar changes and our cyclones, storms, droughts, and floods. Were those years marked off by any special meteorological peculiarity? For if there be any connection between the sunspot period and weather, so marked and so long continued a minimum must surely have produced a most notable effect.

Again, faculæ and prominences vary in their number and size in close though not precise accord with the spots. How were those years distinguished for these phenomena? Cassini's allusion to faculæ, quoted above, is very significant, and points to as decided a dearth of the bright as of the dark markings of the solar surface. Unfortunately, there were no spectroscopes then, and we ask in vain for prominence observations. But there were a few total eclipses—those of 1654, 1659, and 1661—and they give us no hint either of red flames or of corona, whereas we get observations of both from the eclipse of 1715, and of the red flames from that of 1706. We cannot, therefore, say what shape the corona, which now appears to vary in such sympathy with the spot curve, had during the period. Is it possible that, like the spots, it was in a state of partial abeyance?

Rightly and worthily was Schwabe honored for his demonstration of the solar cycle, and for the great advance in our knowledge of the sun which that rendered possible. But the demonstration due to Wolf and to Spoerer of this strange interruption of it is equally necessary to be borne in mind.* The sunspot theory which ignores it stands self-condemned. The very fact that the case is so anomalous renders it of more importance, and it may well prove of the greatest value to us in guiding us to a right understanding of the solar ebb and flow. In the meantime it stands as a warning to us against too hasty a generalization. Two centuries of a fairly cyclical oscillation would not have justified us in premising a like condition of things in the half century that preceded them. Clearly, however likely we may consider it that the present cycle will run much the same course as its immediate predecessors, we are not justified in prophesying it. What has happened before may happen again, or even its reverse; for who shall say it is impossible that, as for so long a time the keynote of solar energy was lowered to such a degree, so for an equal time it may not be proportionately raised? If so, we or our descendants may see our sun as an unmistakable variable star; for the vague traditions which have reached us from the middle ages may be realized, and for a greater or less time the sun may be so covered with spots as to lose a very appreciable portion of the light of its general surface.

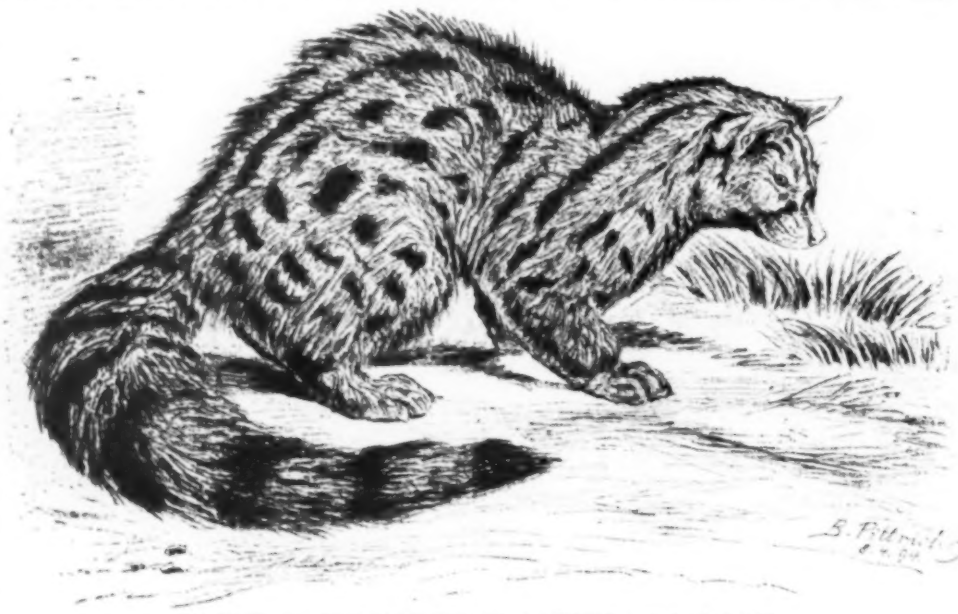
In this case we should probably find the faculæ and prominences developed in something like the same proportion, and the sun might well earn the title of a "bright line star" in a sense which we have never known it to do as yet. And its spectrum would approximate to those of the transitory enigmas which have puzzled us so sorely—the "temporary" stars of Auriga, of Norma, and of the Northern Crown.—Knowledge.

* In addition to the prolonged minimum referred to by Mr. Maunder, the theorist should bear in mind the irregularities in the length of the sunspot periods shown in Prof. Rudolf Wolf's sunspot curve, published in Vol. XLIII. of the Memoirs of the Royal Astronomical Society. Prof. Wolf's diagram represents many years of patient historical research, and shows in a graphic form his conclusions with respect to sunspot activity from 1745 to 1875. According to Prof. Wolf, the periods of sunspot maxima and sunspot minima do not ever occur with precise regularity. The variations from the mean seem to have been especially wide at the latter part of the last century; thus according to Prof. Wolf, there was an interval of fifteen years between the sunspot maximum of 1789 and that of 1804, and only nine years between the sunspot maxima of 1769 and 1778.—A. C. Ranyard.

TWO CURIOUS ANIMALS IN THE DRESDEN ZOOLOGICAL GARDEN.

THE two accompanying engravings show animals of the cat and dog family respectively; the former, a genet, belongs to the viverridæ family, and bears a strong resemblance to the marten family, but, while its whole appearance places it on the connecting step between the cats and the martens, its other characteristics place it unconditionally in the cat family.

The dog shown in the other engraving (Canis procyonoides and viverrinus) is from Eastern Asia, and



GENET IN THE ZOOLOGICAL GARDEN AT DRESDEN.

his whole appearance indicates that he is the connecting link between the dog and the marten. His head greatly resembles that of the latter, while his body resembles the wolf.

The genet shown is a representative of the smaller of the two species found in Africa (Viverra genetta, Genetta senegalensis), and differs from its relatives in the length of its hair and the peculiarity of its marking. This little creature is a terrible enemy to all small animals, such as rats, mice, and even birds, which it is very skillful in catching, because of its cat-like suppleness. Although this would seem to indicate that it is a bloodthirsty beast of prey, it is really a very peaceful and sweet tempered little thing. The specimen in the Dresden Zoological Garden is very gentle, and, if not molested, sleeps nearly all day, moving about the cage only at the usual meal times. But it is very lively in the evening. When settling for sleep, it will turn around two or three times and then lie down with its bushy tail about its body, and its head almost hidden under its tail.

The night is also the time that our little dog shows most life. It will lie in the corner of its cage all day long, but late in the afternoon begins to rush about, and sometimes he will stand still with his nose up, sniffing the air as if trying to determine the nature of his surroundings.—Illustrirte Zeitung.

THE NANDU—AN ORNITHOLOGICAL SKETCH.*

By ADOLF ERICH BOECKING, Ph.D.

THE sketch of bird life which I propose to lay before you this evening is a condensed abstract from a monograph in Wiedemann's "Archiv," the German medium for scientific zoology. Thence it has found, in quotations, its way into Brehm's "Thierleben," and other biological works. It is altogether taken from life, and the study of the subject in the field, when as a younger man all that was then known in the premises did not satisfy a critical mind, has afforded me more genuine pleasure than the subsequent generous acknowledgment on the part of Darwin, Troschel and Burmeister naturally will carry with it. In transcribing it for the

* Read before the Scientific Society of San Antonio, November, 1890

first time, and for this occasion, into English from the original field notes, I have been careful to leave untouched all sides of the question in regard to the sex life of the apteryges, which as yet await solution. Only what has come to my personal knowledge as facts, and facts which since my researches have not been taken up by any other naturalist, I herewith offer to you as a contribution, for what it may be worth, invit ing further investigati n.

THE AMERICAN OSTRICH

is the largest bird of either of our western continents, and one of the survivors of a more numerous kinship, which found its apex during the Upper Neozoic and Post-Pliocene in the dinornis of New Zealand and the aepiornis, the moas of Madagascar, the last living representatives of which have lapsed into extinction not longer ago then the end of the last and perhaps only during this century, their unfossilized bones and eggshells being on exhibition in all our more important public museums. The living struthio, the emu, the muruk and kiwi (all names, by the bye, which bear their onomatopoetic significance upon the face) are his first cousins, but in common with these he stands on the dying-out roster, if man refuses to lend a hand, and by domesticating him, secure to the species a continuable lease of existence.

The bird's habitat is that vast complex of plains known as the River Plate territory, but it includes many of the upper valleys of the lower and southern tributaries of the Amazon system, as well as the Sierras of Eastern Brazil, and stretching from the virgin forests of Bolivia, the Gran Chaco and the Paraguayan Misiones in its immense extent deep down into Patagonia, laterally flanked by the Atlantic Ocean in the east and the Cordilleras in the west. The aborigines name him nandu, a vocal rendition of the cock's call during pairing time. With the Guaranis in the north (in Portuguese spelling) he is the nbandu-guazu. The Brazilians call him improperly emu, and with the Chilenos in the far south, where in straggling troops he seems to transgress the low Andes, he is the cheuque.

There are but two good species recognizable, although there are climatic races in both. The one is the smaller and more densely feathered "Darwin's nandu," south of the Cusu-Leubu, which Alcide d'Orbigny has called Rhea pennata (the avestruz petiso, or pony ostrich of the gauchos), the other is the larger Rhea Americana to which Vieillot stands godfather, and which is the subject of our sketch. For the entire pampa proper of the Argentina, the largest southeast half of Brazil, the east of Paraguay, and the whole of the Banda Oriental del Uruguay, this latter remains by far the most conspicuous figure in the ornithological fauna. He is a specific bird of the plain and evitates the jungle no less than high mountains and abrupt hills, but he cherishes the open algarroba and espinillo bosquets of the steppe, and the islands of scanty and thorny verdure, which intersperse here and there the grassy ocean. The center of his home may be looked for where the 32° lat. S. is intersected by the 63° and 64° long. W., and hence he spreads in gradually diminishing numbers up to near the equator, and down to the less than temperate reaches of the Rio Colorado. Upon the space roughly so circumscribed, there are few spots where the nandu is entirely wanting; he is thicker or thinner represented everywhere where his principal sustenance the grasses grow, even upon the sea coast, the lower foothills of the Andes, and the Salitrales of the Urre-Lauquen, those extensive niter fields with peculiar plant life, black as Erebus in winter and dazzlingly white in summer time.

The cock lives during the period of generation with from three to seven, rarely more or fewer, hens in separate family conjunction upon the range selected by him, and valiantly defended against any would-be aggressor. The rest of the year they conso idate with their young into herds of half a hundred or more individuals, and as firmly as the nexus of the family during the contract season is adhered to, just as loose is the cohesion of those larger and more scattered congregations; in fact the first accident, as an intervening rise of the ground, while they are pasturing, a night surprise, or a pampero suffice to sever them, and cause stragglers to join with the first feeding herd with which they may fall in. Nevertheless, aimless as this vagabond roaming may appear on first sight, they never go beyond certain limits of their "querencia," the home range. I had an opportunity to ascertain this pretty closely by the aid of a wounded male exemplary, the right wing of which trailed, not having healed normally. This ostrich was a landmark, and went with my peons by the name of "el lastimado," the cripple; he would perhaps for whole days not be seen from my point of vantage, where he was remarked by the vaqueros from three to four miles to the right or left of us, but he was sure to turn up sooner or later, followed by little or much company. The nandu on the whole is a peaceful burgher, leaving everybody and everything alone, only in spring he musters pugnacity from jealousy, and then uses his bill and feet to a purpose, the wings serving him as a shield for defense. When wounded by a shot, they make some show of temper, but it amounts to very little. Their distinguishing peculiarity, their strongest as well as weakest point, and which meritedly has gone into a proverb, is their never-flagging appetite, caused by the insubstantiality of their nourishment. You will hardly see them otherwise than feeding. In spring, when the predominant grayish-brown tempera tints of the pampa which characterize the brief interruption of plant growth make room for the green, and the various kinds of "trebol" or clover make their appearance before the grasses, he feeds upon these and insects; it is the season when his plumage is brightest, his deportment stateliest, and when he utters that sonorous guttural call in minute pauses to which he owes his name, and which can be heard for a league, his epithalamium as well as his pean, a challenge, an invitation, a warning and encouragement in one. This call never missed its effect upon myself, when camped out, with nothing to keep me company for perhaps a hundred miles, except my horses and dogs, I heard its loud-drawn ring vibrate through the starry night. It was the reassuring manifestation of life and peace at the same time amid the overwhelming solitude and stillness. As long as this sound reverberates you are safe from every surprise, you will hear it even in your sleep, and only when it ceases, then you wake up with a start, the horses interrupt their cropping and listen, and the dogs take in the wind to ascertain what it can be. Of all the watchful pampa creatures, the ostrich is the most vigilant. When the season of love is past both sexes emit a whistling noise, without

CANIS PROCYONOIDES AND VIVERRINUS IN THE ZOOLOGICAL GARDEN AT DRESDEN.
DRAWN FROM LIFE BY B. PITTRICH.

any other modulation but what is conditioned by the different size and age of the birds, and is not often heard, over all in the height of summer, and when you catch it then you may be sure that it is a troop of young under their father, who uses it as a gathering call among the espinillos and artichokes. A sound of distress, terror or pain I have not heard of them under any circumstances. A tame bird when in a passion rustled his wings like a turkey. In spring they are lively and day and night on the move. In summer they hold a four hours' siesta at noon, like all the tame and wild higher animals of those countries, and then fetch that much off the night, to indemnify themselves for missed meals, but in their whole nature they are true diurnal beings, and during the cold season, when they are altogether mute, they rise and go to sleep with the sun.

All his senses, perhaps the taste conditionally excepted, are extremely sharp. I had often occasion to put them to the proof, and the hunter will have to observe every current of air, as also to avoid the least noise or smell, if he means successfully to approach him, even then in most instances to find out that love's labor is lost. His mainstay and daily bread are the grasses and unripe flower buds, even those of the thistle; I have found the latter in all the stomachs which I have investigated during their season; still, whether he takes them as an aliment or only as a hors d'œuvre to help to digest the other food, I am unable to say, but incline to the latter conjecture, inasmuch as gravel and grit, of which he needs large supplies, in many parts of his habitat are unknown quantities. In autumn they fancy the sausales, the willow-covered banks of streams, for the myrtle and other berries, of which they are inordinately fond. Where there is no other cover, they retreat into the paja, cut grass, or the cardales, thistle thickets. The cardoon, or wild artichoke (Cynara cardunculus), was brought over from Spain at the time of the conquista already for culinary purposes, and has now grown wild, densely covering thousands and thousands of square miles with their prickly leaves and twelve feet high flower shafts.

On the level surface the storm winds carry the heavy seed, which for that purpose is endowed with a pappus, to great distances, and so it comes that the cardales grow in extent from year to year, restricting thereby the prairie and forming a first step toward a natural afforestation of the original grass land. For variety's sake and out of caprice the cardoon leaves, when tender yet, are here and there eaten by mules and horses, but all other herbivores abstain from them in contempt.

The nandu cares nothing for the millions of thorns, which force the horseman to protect the chest and legs of his mounts with sheepskins, if he has occasion to perequitate the cardal for days; on the contrary, he favors it in predilection, because the shade which its broad leaves afford to the soil permits all sorts of low herbage to survive, when in the open pampa everything green is kiln-dried, and by the winds ground into a brown powder, of which the bird cannot make use as a diet, although the cattle lick it up and grow fat upon it, so long as they have water to drink. In winter the nandu eats anything green which he can find, and selects in preference those localities where the domestic flocks have kept the pasture short and tender. A favorite place of his at this season is abandoned rodeos, spots where in bygone days the herds several times a week were rounded up for control and gentling, and where, on account of the great accumulation of animal dung, the herbage grows more luxuriant. Where the ground permits of it, little pebbles and sand are found in the ostrich stomach, together with partly digested grasshoppers and the elythra of beetles, but I have in vain sought for snakes or reptiles of any sort, notwithstanding the positive assertion of the gauchos to the contrary. Neither do they feed upon the dry and ripe seeds of the many grasses which in their season render the venison of the deer and guanaco so juicy. Even tame nandus, which otherwise accommodatingly make small distinction between the food which you may have to give them, never touch raw Indian corn nor grain of any kind. On the other hand, they are like most game, greedy of imported agricultural crops, and, should a troop once have found out a hole in the fence of a turnip or alfalfa field, then there will be patching or watching necessary, if the last green leaf is to be saved. They drink but rarely, and it was only during the hottest season that I have remarked single individuals, never whole troops, dip their bill in a canada, and in holding aloft the head, allow the water to flow down the gullet; the greater part of the year the rain and dew upon and the humidity inherent in their food plants seem to suffice them.

They never bathe in the water, but puddle in the dust. The excrements are frequent and copious, and contain much unassimilable matter and lime, their nourishment largely growing upon limestone formations; and concluding from my tame exemplaries upon the free ones, I imagine that they occasionally swallow dry bones, of which there is no dearth in the pampa. There is no urinary bladder, as in the African species; he also wants the penis, and so the copula takes place as in the majority of birds.

Ostriches, as a rule, are in fair condition, but in spring they are lean, because of their restlessness incident upon the forthcoming pairing. With the advent of October, which signals the springtime of the southern hemisphere, the male collects about him from three to seven wives, and fights the other cocks out of the neighborhood, and henceforth the egg-laying begins from the first week in December—a little earlier in the north. The very old and the immature males, together with the yearling hens, which then have not yet attained puberty, form at this epoch separate herds, roaming aimlessly about, and being chased in all directions by the gentlemen in power, who as "peres de famille sont capable de tout." Very old hens can be seen among such flocks, who have outgrown mother obligations, and by virilescence even acquired the black gruff and throat feathers of the cocks, whereas the normal color on those parts is a dark bluish slate gray.

The first eggs, which the vaqueros bring home singly, are the so-called guachos, orphans or foundlings; they are found in the prairie here, there and everywhere, where the mothers happened to be overtaken with parturition. But by and by the cock resolves upon a regular lying-in place, and from that time forth the normal ovipositing of the entire harem takes place in that particular spot, until the whole complement is achieved. This community or collective nest, as a rule, is merely a shallow excavation in porous ground on some dry place and which is beyond reach of high water, laterally sufficiently concealed, and protected against the winds by high grass or bushes. They never allow a tree or shrub to overshadow their eggs though, and in the stock-raising districts the nest is usually one of those flat hollows which the half wild cattle have wallowed out with their shoulders to free themselves of the grubs of the œstrus flies, and where in this manner the family finds the heaviest labor for nidification handily prepared.

Where there are no such bullock bathtubs available, the male bird simply scratches the ground bare of the turf and lines the round so formed with a few grasses at the edge for the hens to lay their seven to twenty-three eggs into it. All the gauchos whom I have questioned have told me that one would meet occasionally with hatchings of sixty eggs and over, and to D'Orbigny, Darwin and Poeppig they have sung the same tale; so that those gentlemen all make mention of the hearsay in their writings, but the Castillo Indian is a born embroiderer and prevaricator, constitutionally chary of truth, whose flourishes must not be taken by the letter, and I have during three seasons, in very different regions of the ostrich range, and where I was instigated by a set purpose of getting clear about this point, investigated every chance that offered, and in no instance found more eggs than twenty-three in one set. Individually it goes without mentioning that each fully developed nandu hen may be safely credited with from ten to a dozen eggs, but from five to seven times that number of the size of an ostrich egg could find no room in the circumscribed place, nor could one bird cover that many, and even if hatched, how could the young afterward all find the necessary cuddling room in his plumage? Around the nest, immediately from its margin to a distance of fifty yards, one always finds guachos, which are of younger date than the eggs in the nest. This may readily be made out by the color of the shells.

A fresh laid nandu egg is of a delicate creamy complexion, splashed irregularly with greenish yellow

spots around the pores; but this color bleaches fast, and once exposed to the sun, at the expiration of one single week, is already chalk-white all around. Now, after the nest eggs are so all completely blanched, there come as many more of these supplementary guachos in all stages of freshness, scattered at random inside a certain radius around the nest focus. That such latelings are not admitted any further in the nest stands to reason, but the rationale for their existence at all is not quite so evident. We all know how nature has implanted into her products a greater desire to propagate their kind than the actual increase seems to warrant, and that in all orders of organisms, plants as well as animals, there come to existence a great many more germs than complete beings could find room, a safeguard it would seem against all noxious contingencies during development. But this depositing of eggs into places where there cannot be the slightest probability of a successful evolution cannot be accounted for in any other way but the most complete purposelessness of natural action. Lichtenstein, in his African travels stated, with all the weight of his personal authority, the canard first, that the presence of such eggs confirmed the native contention that they served as a first food for the newly hatched young; but that this is a mere negro tale is demonstrated by the fact that no bird's egg in existence is able to stand a five to eight weeks' exposure to an equatorial sun, alternating with very low night temperatures, without rotting. No responsible naturalist can stand forth for the fact of having seen the father break such adventitious eggs, and the pullets eating the contents, nor has any one ever endeavored to do so. Try yourself once a brood of machine hatched ostrich pullets with pheasant's food and you will see how they carefully pick out the green stuff and let the egg part alone. Among the mollusks we find it as a normal occurrence that inside the egg bags, deposited with certain genera between the parent gills, a given low percentage of ova only develop regularly, and the entire balance is there merely as so much forage for the sustenance of the larvæ, but among so highly organized beings as birds are, such cannibalism would be a solitary exception. The young ostriches, when free of the shell, are able to take care of themselves, and from their second day on feed merrily upon grass blades and insects, for which their bills and whole environment fit them admirably, and not upon white and yellow of eggs, fresh or haut gout unboiled, for which their mouths are not adapted.

As soon as the nandu nest has received its full complement, the cock administers to the business of incubation alone, and the hens remove themselves carefully out of sight, still without overstepping the boundary of the chosen range, and form a quiet ladies' club of their own, which offers no further allurements to any vagabond swain. The father covers the eggs assiduously and takes regular pains to turn them over every day with his bill, an operation which takes considerable time. He never deserts the nest during the night, and as long in the morning as there is dew on the ground, but later in the day he will quit the eggs at uncertain intervals, which seem to be regulated by the temperature, in order to feed. That of an occasion such spells of absence may be rather long without detriment to the embryo, I accidentally became aware of and was permitted to determine by the watch.

One afternoon while fishing in the Aguila, I remarked a nandu cock, unconscious of my presence, standing up from the nest and unconcernedly feeding for four full hours before returning to his family. Ere nightfall I flushed him and counted the eggs, and a couple of weeks afterward the whole young company could be seen busy after hoppers, without a single addled egg remaining in the nest. At the beginning the cock will sit but loosely, and timidly steal off at the mere suspicion of danger, but later on duty grows upon him, and then he often only jumps up when the horseman is almost upon him, to the apparent discomfiture of both parties. On such an occasion you will remark that he has not treated his children gingerly, some eggs in his terror he will have trodden upon and smashed, others jerked out of the nest. He will for a few seconds blow himself up, so as to appear double his natural size, and even feign an attack, which the frightened and rearing horse makes mien to take seriously, but he will speedily think better of it and betake himself off in a slow and limping zigzag gait to direct the attention upon himself and away from his treasure. Were you to follow him then your mount would find out to his cost that he has lost none of his running, but you quietly turn bridle and leave the noble fellow alone. Frequent inspection of the nest is not at all to his liking, still in the more inhabited parts he has to submit to the abstraction of single eggs often enough, and he seems to take the unavoidable with ostrich philosophy and dignity, but he will not abandon his penates altogether unless the disturbance surpass in extent even his equanimity. Whether they complement such egg robberies I am unable to tell, for when I had to commit them myself it was usually on the march, and there was no chance for subsequent observation, yet it is altogether improbable on account of the long period of incubation, it be then before the set is completed. The gauchos could give me no other clew than their exasperating "Puede ser que si, puede ser que no."

An ostrich egg in size is fully congruent to the size of the birds themselves, but they are, like these, very unequal in volume among themselves, presumably caused by the difference in the age of the mothers, and you find them from the caliber of the egg of an Embden goose up to over five inches in the longitudinal axis. Seven to eight weigh a Spanish arroba. The old birds are said to defend the nest against zorrillos (Conepatus mapurito, Gmel.), comadrejas (Didelphis sp.), the large tri-colored lagarto (Tejus teguexin, Linn.) and snakes, but I have never found death signs of any of those prowlers about the nest; on the contrary, upon different occasions I have encountered robbed and empty shells of guachos right in reach of the hatching bird's beak. Carrying a whole nest full of nandu eggs home on horseback without any other toilet but sombrero, camisa y pantalones, and without breaking any, is a trick which I had to learn, but well do I remember, when a newcomer, once having been compelled to go ipsissimus into soak in a creek to soften the contents of three eggs, which, foolhardily, I had endeavored to secure and get home between my skin and shirt, above the waistband. By the horse's cantering the clumsy things had become broken against each other and the equivalent of four dozen biddies had run down into my boots, rendering the pastoral outfit as stiff as a plank and irremovable except by means of a knife. Had I not become aware of the state of my plight betime, I might have had to take the saddle also with me into the arroyo.

After six weeks' incubation, with the beginning of January, the first young pullets make their appearance, and when a fortnight old they measure already a foot and a half, and look exceedingly pretty in their downy striped livery. When a few days out of the shell no pedestrian is able to overtake them on a run in a free field; before this it may be done and is often done, but there is always danger to step upon and hurt them, because of their habit when nearly reached of suddenly crouching down. It is only with difficulty that they can be recognized in this posture, so closely do they mimic the surrounding objects. For about five weeks they follow the father alone in the most protected parts of the range, and before sundown you may then hear their little calls in the cardal, till gradually, one after the other, the old hens will put in an appearance again and share their part in the family incumbences. In fall, i. e., in April and May, the youngsters have exchanged their fluff for a suit of feathers, but these first jackets as yet are only a dirty yellow ash color, whereas the mammas by this time parade in a fresh toilet of Quaker gray, which they have donned during the period when the father was taken up with the more serious cares of population. At this season the flocks exchange the cover for the open prairie of nights, because jaguar and cougar and sundry other objectionable people have growing families of their own by this time, and render the thickets undesirable. In a troop of young birds the cockerels may be early distinguished by their erect bearing and larger size, and in each flock also you will find single individuals which, for some cause or other, have not been able to keep pace in growth with the balance. What may be the "why" of this remains conjecture, but I have remarked it in hundreds of coveys, and also that, when fairly outgrown in the spring ensuing, no salient differences in size can be detected any further, so that by that time the rickety ones either have recuperated or else succumbed to the "temporales," the wintry blasts or other accidents.

Among the emus there are two established color races, but among the nandus no such thing occurs, and there are neither melanoids nor albinoes, not even pintadoes or piebalds. Also as to the age which they attain in a state of freedom, and under normal conditions, experience teaches us nothing. In multiplying the time of growth, two years by seven, a ratio which holds good among kindred forms, we shall have fourteen years more or less, a very probable duration of their life span. At different times, when on the march or hunting during the cold season, I have found full grown nandus, living yet, but helplessly lying in the grass, showing neither wounds nor symptoms of poisoning, and my peons said of them, "que tenian las patas pasmadas de frio," that they had frozen their legs. May be that this was so, although in no instance was there any extraordinary sinking of the temperature, but it may be possible also that they were either senile specimens succumbing to marasm, or else birds run down by a red wolf (Canis jubatus, Desm.) or hounds, and stiff from exhaustion. Enemies, the ostrich has few among the animal world. True, off and on one must fall a prey to one of the larger cats, and young ones may oftener serve as a meal to an eagle, fox or boa, but he is too circumspect a vidette as that this could happen often. Of course, all the guacho eggs must find a grave in the stomach of some higher or lower animal, but they are doomed anyhow, so that to the developed bird of serious enemies there remain only man and the pampa fires (quemazones), especially the latter. The inhabitants of the pampa collect indiscriminately in spring all the eggs which they can find, even the partly incubated ones, because they are too valuable a change in their monotonous diet as to bear neglecting. One single one equals in substance fifteen to twenty hens' eggs, and it needs two famished hunters' appetites to master it, yolk and white together. In the field it is customary to chip off one end, to empty the albumen on the ground, on account of its slightly coarse texture, to add some salt, red pepper and fat, if the latter be at hand, and then scramble the contents over the camp fire in their own shell. To cook a nandu egg hard in boiling water it needs good forty minutes; this is the usual method of preparing it at home, and then partake of it in the guise of a salad with lemon juice, but it furnishes also splendid omelettes "a la cana," and lends itself readily to all modes of preparation for which the eggs of the barn yard are employed. They cannot be kept for any length of time in that hot climate, where all facilities of cooling contrivances are wanting, and corrupt soon on account of the porosity of the shell, which admits the atmospheric oxygen rather liberally, and then either burst with a loud report or else dry up. During my novitiate, in order to practice my eye in a correct estimation of distances, of which in those endless plains and in that clear air my vision, as yet, was uncertain, I made guacho eggs my favorite target aim, and they would then, if hit, explode with a pop and grace the neighborhood with their peculiar perfume. All destruction of eggs by man falls short of the damage done by prairie fires, but I need not dwell upon this in presence of a Texas audience, as I have done in the more extended report.

Of parasites of our bird only two have come to my notice. The one is the "agarra-pata" (Ricinus Rheæ, mihi), a kind of tick peculiar to him, and the other is a vermiform scolex, the concentrically agglomerated cysts of which may be found at all seasons between the costal muscles and the skin, right under the wing. It feels to the touch like the larynx of some small rodent, and is, as far as I know, not yet scientifically determined.

The damage which the ostrich causes is absolutely nil, it be then that the occasional inroads by the vanishing herds at the boundary of civilization, in stealing some clover, or a few watermelons, be reckoned up to him. On the other hand, his usefulness in destroying noxious insects and various burr seeds, such as the "Abrojo" and "Flechilla," while they are in a green and tender state, is incontrovertible. Whoever has scrutinized one single nandu stomach during the months of December and January will readily bear me witness as to the quantity of pestiferous seeds which he so renders harmless; and to do away with the waco grass alone in our pasture inclosures, his introduction into Texas by the flock masters would repay any reasonable outlay.

The venison of the bird is coarse, resembling somewhat horse meat in color as well as taste, but it is certainly not inferior to the average beef which our butchers furnish us, and it is regularly eaten by the Indian, the gaucho, and the hunter. Domestication would speak an improving word in this respect, no doubt; still the fastidious Caucasian on the other side of the equator makes only use of the pullets and the wing muscles and liver of the full grown. My own deer hounds and setters persistently refused it when raw, even when they were on short rations, but they would gnaw the broken pieces of the roast. The setters went further yet, and never once marked the track of the bird. During the prime season the fat is copious; it is of an oily consistency and deliciously sweet when fresh, good for any culinary purpose, but it, too, cannot be preserved for long, and once rancid is not fit to grease a "riata" with. It is employed by the natives in tanning green game skins, and renders the guanaco robes as supple as a glove. The nandu skin itself, no doubt, would furnish a tolerably good leather for fancy purposes, but it is as yet not utilized. Out of the skin of the neck, stripped unsplit, the Chinas make children's stockings and purses, which they call "chuspas." The calotte of the abdomen, with the showy tail plumes left on, according to the Jesuit missionary Dobritzhofer, served the Abipone chiefs for a headgear. Out of the long feather shafts of the wings, deprived of the vanes, the young people make stout snares, which they fasten to the end of a bamboo pole and catch the tinamus (Tintamus solitarius, Vieill) with. The men plait out of the same very graceful, artistic and resisting bridles and horse trappings. What end the long wing and tail plumes serve for ladies' adornment you all know, and since the art of dyeing them in any desired shade has been so widely evolved, they have become an important article of luxus commerce. The smaller plumes of the body, which furnish the well-known dusters and hearthrugs, are exceedingly cheap, but the long ones are worth in the import market anything between ten and twenty-five dollars per pound, and of recent years make a serious competition to the African article. The black feathers on the felt hats of our own boys during the late war between the States were nandu plumes, but the three historic feathers in the crest of the Prince of Wales come from Africa.

To the lover of nature our bird in his unbounded freedom is a never-failing source of interest. In the relation he bears to his environment, to the plant and animal life of his habitat, to the wild, half wild, and civilized representatives of humanity, with all of which his life brings him into contact, he displays a finesse of observation and readiness of adaptation which at once remove him from the slander of stupidity, the stigma of which has so long unjustly clung to his reputation. As in the case of the goose and the ass, who in their natural state are types of sagacity, so in the aspersion of the character of our bird it is the old sinner tradition which is stupid, not the other biped. The nandu does not hide his head under a stone in order not to be seen, because stones are very scarce where he lives, but he lifts it up proudly full six feet from the ground, every few minutes, and nothing escapes his vision, and the impressions which his brain receives are soundly worked out by his thinking machine in such a shape, and to such an end, that he usually comes out best in the unequal contest with his detractor. Around the habitations of peaceful white settlers, who have neither time nor inclination to interfere with him, he becomes so tame that he unconcernedly mixes with the poultry and the milch cows tied to the "palenca," as if he were one of them. As consistently shy as he remains here, too, of people in the saddle, just as fearlessly he only cedes the step to persons on foot if they are not followed by dogs; a true picture of sham domesticity. The gauchos, who never walk on foot as long as there is anything on four legs to bestride, treat him without consideration, although they call him a real "ave," a bird, while all the rest of the feathered tribe are only "pajaros," sparrows, and their dogs suffer none to approach the homestead. So it comes that he is never seen around a native rancho, and among their herds only at a respectful distance. Oftener he may be beheld among a family of "venados" (Carincus compestis, F. Cuv.) or "guanacos" (Llama huanacos, Molina), and then one will observe how alternately then one, then another individual of either kind will lift the head for a look around, and both together skim off like a whirlwind in one and the same direction at the faintest suspicion of danger. Before a horde of puelches or pehuelches they tear away in deadly terror. For hours they will run straight on, communicating the "estampedo" to other troops, who will join; cattle and horses will catch the infection and gallop toward their rodeos; even the chickens on an outpost will demoralize, if such a wild hunt passes them, and clamorously hide in the "ramada" of the "gallinero." And the pioneers themselves understand it too, and block the shutters, looking to their arms. A curiously unneighborly feeling exists between the little teruteru (Vanellus cayanus, Gmel.), the spur-winged lapwing of the pampa, and our friend. Once in a while, by inadvertency, it appears that the larger bird steps upon the brood of the smaller, for no sooner shall a nandu approach the domain of the latter, when at once "Holland is in distress;" vociferously they will hover over him, pouncing and swooping by turns upon the giant, not without inflicting sensible punctures upon his head and neck. For some little time this seems rather to amuse the nandu, who jumps aside, dodges, or parries the blows with his wings; but pertinacity gains the day over great good nature, and when the puny tormentors at last have brought him into a trot, they will mount high into the air screaming out their victory to all the surrounding peewits.

There are various ways of hunting the ostrich. The Indians and gauchos kill him for his flesh and for sport, the former with the "Bola brava," which has only two balls joined by a six foot cord of rawhide, and in the hands of an expert is a most murderous weapon,

the others with the "Bola mansa," or bola for short, which has three balls on shorter connections, and is not always so unerringly fatal, but delivers the game living yet, if crippled, into the hands of the captors. It is more a hunt for displaying their horsemanship and resources, or testing the mettle and staying capacity of their horses, than to get into possession of a quarry. For such a chase it is customary that two or more cavaliers take part, and were it only for the betting. Leisurely they will approach a troop of birds under wind, as near as the cover will permit, and the moment that the herd becomes restless, they deploy and give rein. The first care is always to cut off one individual from the troop, and as soon as they have succeeded in this, the chase is upon him or her alone. In walking, the ordinary width of step of an ostrich is from twenty to twenty-four inches. In trotting he lifts the wings a little like the swans do, when they want to catch the breeze, and nonchalantly covers three feet and a half with each foot, the head high, and surveying his pursuers over the shoulder. When he sees that the latter mean business, he sweeps out with lowered and stretched neck, making saults of five feet each time, and with such celerity, that his legs cannot any further be distinguished. When skimming so over the ground he will suddenly deviate upon one or the other side from the straight line at an angle of 25° or 30°, and to aid him in doing this, he elevates the inner wing perpendicularly, and presses the outer one tightly to the body, but all in vain; for in almost as short a time as the description takes, the young men are upon him, and that cavalier who happens to be nearest his left side throws the bola, which in lacing together his head and neck, sends him spinning like a monster feather ball, and kills him by the momentum of his own impact with the earth. It is a thrilling instant, when in the headlong course the bolas so fly at a tangent, describe graceful curve in the air, and after revolving a few times around their center of gravity, upon the very touch lay low and still what a moment before was the fleetest runner in existence. Should, what does not happen often, the first bola miss its aim, then another horseman is ready at hand to continue the game, and if the bird succeeds not in gaining a swamp, where the horses get mired, or a piece of wood, where the weapon becomes inoperative, he is lost every time. The dexterity of the Indians is famous, and the half breeds are just as expert with this native weapon as they are fond of its use; but not only do they themselves rejoice in this sport, their horses are just as passionately given to it, and I have had in my own possession such "parejeros" who, upon perceiving a nandu, at once would change into a gallop, and only very reluctantly yield to the bit. Time and again I have assisted at these hunts, and have found that once started, the nandu is not very particular as to the direction which to take. He dislikes running with the wind, and where there are bushes in sight he invariably steers for them, and into swamps and shallow lagoons he will plunge without flinching; gullies and creeks of a dozen feet he will leap with apparent ease, where in the middle of the jump he then will just once flap with his useless wings, in mechanical remembrance of olden times, when his remote ancestors used them yet to a better purpose, but steep banks and deep or broad water he avoids. I have not once seen him swim, as related by Peoppig, and upon the guaranty of an employe of the Falkland Island Company by Charles Darwin; on the contrary, all the pains which my men and myself at repeated times have given ourselves to run either a troop or a single bird from a neck of land into the swift flowing and tolerably deep Rio Negro were all in vain. The birds would either swerve off under cover of the fringe of bushes or else overcome their timidity and break through our line. I have asked Mr. Darwin later on about this point, and he told me that his informant had seen ostriches of their own accord twice, in crossing and recrossing, take to the Santa Marta and swim it from bank to bank, but it did not occur to me then to inquire whether it were pennatas or Americanas which his Mr. King had seen, and not many months after this Darwin died. I am ready to concede that an ostrich, in case of stress, may be as able to swim as I have turkeys, pigeons and once a gray partridge seen do it, but as to his taking to the water naturally and voluntarily is against my experience with him. Cattle and deer in the pampa will indicate to the traveler the nearest ford in a river, by crossing, if he cautiously stirs them toward the water, but the nandu is worth nothing for this purpose, and I have never met one upon the innumerable islands and sandbanks in the Parana and Uruguay Rivers, be they never so near a bank. He is no lover of water.

In coursing the nandu with hounds, a mongrel breed of lurchers is employed by the natives. Thoroughbred greyhounds cannot be used to advantage in the tall and rank herbage, on account of their long and flat sweep over the ground. Compelled to high arched bounds, they become speedily lame at the shoulders, and being besides gifted with but little sense of orientation, they are constantly in danger of losing themselves in the grass and perish, or else consort with a pack of simarones and become dreaded marauders. In coursing care is to be taken that in slipping the hounds one of the leash at least be an old hand, for the quarry has an inconvenient habit of kicking backward at the moment of gripping, and the young novice is more than likely to meet with a rough and tumble or wound, and so become intimidated, if an experienced dog at the crucial moment be not forthcoming to stay his nerve and show the over-arduous youngster the trick of bounding from the side at the throat of his game. I have done my own coursing with a brace of kangaroo hounds, but the brave boys never showed the same willingness after a nandu which they would display after four-footed game. I conclude that there is something in the emanations of the bird uncongenial to the canine nose.

In stalking nandus with the rifle one will find that the fellows can carry a good deal of lead before giving in. Over all, if the shooter as he is almost sure to do at the beginning of his experience, aim at the shoulder part. The besetting sin of the bird is gluttony, and his weakest anatomy are the entrails, always distended with their contents. So in taking aim it is advisable to view at what is behind, not what is before and above the tibia, if you wish not to have a long stern chase, with the probability of finally losing your game, perhaps after days to stumble upon the feathers which the caranchos (Polyborus tharus) have left, to prove that after all your shot was not a miss. If the bird turns his back and surveys you with twisted neck, uncertain as to your intentions, he offers his black median line, which covers exactly the backbone, as a splendid target, and then of course it matters not so much whether you strike him an inch higher or lower.

In the more remote parts of the pampa, where humanity is no nest, the nandu shows the same fear of the rider, but seems not to know at all what to make of a person walking on his own legs, and upon this ignorance, as well as upon the curiosity which all beasts of the solitude have in common, not excepting the highest primate, is based a peculiar mode of getting in possession of the bird. If at the Ybicuí, or in the interior of Patagonia, the hunter dismounts sufficiently distant under the lee of an ostrich herd, and then creeps under cover to say a quarter of a mile, he has only to lie down and fix his handkerchief to the end of the ramrod and wave it a couple of times about, when in peeping through the grass stalks he will see at once every head in the air intently surveying the mysterious apparition, or I perhaps say better, disappearance. Presently, the old cock in the lead, the whole company will slowly and cautiously move up in Indian file, they will stalk to and fro, as if fearful to tread upon anything which might cause a noise, they will even feign to resume feeding, but their inquisitiveness remains paramount, and the hunter, if he does not lose patience, or else the wind veer around and so betray him, will see the whole flock come under his very gun. If upon the report one of them breaks down, then the remaining ones will caper around the dying comrade in frantic gambols, as if seized with fits in legs and wings. The report itself concerns them not, if the smell of the powder does not blow in their direction, and there is ample time for the discharge of the second barrel, if so intended. But if upon the first puff another of the company has had a taste of lead, he will strike out, followed by the rest. The wounded ostrich keeps with his companions as long as he can, but then switches off to die. A so-called marking, i. e., certain specific traumatic motions of the body, in consequence of receiving the wound, and which enable the experienced hunter to judge in a crippled deer at once what parts have been touched by the ball, I have never seen in a wounded nandu, but often they would scamper away with the balance as if nothing were the matter, and then through the field glass I beheld them suddenly drop down, stone dead.

If caught early the nandu, like Carlyle's Scotchman, becomes wonderfully tame, and may so semi-domesticated be seen everywhere in his native country. When in this manner kept as a pet, he is never confined, for his attachment to wonted surroundings is so faithful that he is sure to return, even if for days he should absent himself from his foster home. Gaspard, the Savoyard cook, one Sunday afternoon, to the great merriment of the other peons, dismounted "en sans culotte," holding his "chiripa" (native trousers, a cotton cloth, 2 × 5) aloft as a receptacle for four nandu pullets a day or two old, and which he had picked up while on a visit to a countryman of his, to talk "patria unita." I put the little harlequins into a room by themselves, but they had not any idea of what a strategic boundary is, and ran, loudly calling their papa, so persistently against the walls that their heads became sore, and I had more than half a mind to restore them to liberty. But night supervening, they calmed down, huddling together in a corner, and when on the following morning I entered their apartment with an old dry ostrich skin held before me, and strewed some fresh minced meat before them, their natural voracity asserted itself, and from that moment forth they were won over to civilization. Alas, civilization! Later on they would follow me like dogs, even upon my bird-shooting expeditions on foot, and with scores of their wild relations in full sight. Their staple diet remained grass, but they would regard anything coming from the department of Gaspard as a dainty. They preferred fresh beef or mutton to everything else, and when in course of time they had grown and discovered the "dispensa," the meat house, I had to guard the windows with wire netting to prevent their pilferings. With the poultry of every class and clime they lived in unbroken harmony, and one could often see them lying in one jumble with the dogs, like these, to sun themselves in the early morning rays after a raw night.

Pet nandus, of course, cannot be tolerated in the house; they are a trifle too clumsy and country-mannered for a too close intimacy, and then, I am sorry to acknowledge, their innate ideas of meum and tuum are very hazy, repeated whippings notwithstanding, and anything glittering, if not too voluminous, is considered by them a bonne bouche, and in approved ecclesiastical style secured in saccum deponentis.

Their reproduction in captivity admits of no doubt. With the gauchos they are not allowed sufficient peace, and so they lay only guachos, but the late Dr. Bodinus has bred them for years in the unsuitable climate of Berlin, and stocked a number of zoological establishments from his garden. Mr. Bartlett has done the same in Regent's Park, London, and Dr. Schmitt at Frankfort-on-the-Main. Our Texas climate is isotherm with that of a large part of his habitat, and furnishes him isologous conditions. It will suit him admirably. The expenses of having a dozen shipped from Buenos Ayres to New Orleans would not be prohibitive, and inasmuch as the Hon. Edgar Schramm, of San Antonio, an esteemed member of this society, will henceforth represent our government for the Banda Oriental at Montevideo, the idea becomes feasible, and I hope to see some time a couple of sets located in the parks of some public-spirited lover of nature here. May I then be permitted to visit them once in a while, and so keep up and going a friendship of now many years' standing. Quodsi factum felix faustumque sit! And now to conclude:

The question of genitation of the apteryges is not anything like solved. Observations in confinement, made by reliable naturalists, have added to the complexity of the problem, and extraordinary as the struthious propagation always must have appeared to the inquiring mind, disclosures, half discounted, seem to tend to a still more extraordinary character of the whole proceeding. Our knowledge of ornithic generation and the evolution which it has undergone, and is undergoing still, could not be better served than by researches instituted upon a bird of the size and docility of the nandu. I look ahead for some interesting discoveries.

THE USE OF INDIA RUBBER AND GUTTA PERCHA IN MEDICINE.

By A. E. DAVIS, M.D., New York.

WITH one or two exceptions, perhaps, to no other articles of commerce is modern medicine so much indebted for its success as it is to India rubber and gutta percha. This indebtedness exists, to a greater or less extent, in every department of medicine—general medicine, general and special surgery, chemistry, laboratory work, dentistry and hygiene. The uses of these gums have been so manifold and their application so extensive in the practice of the "healing art," that even the far-reaching phrase, "From the cradle to the grave," seems not to be broad enough to embrace these articles. In this day of hygienic medicine we are ushered into the world on a protective rubber sheet, using it, therefore, before the cradle!

Torquemada, who called attention in 1615 to the tree that produced India rubber, remarked the use of an oil obtained from this gum by means of heating (no doubt the same oil that we now obtain by heating the gum—caoutchoucine, that was "of especial effect in removing tightness of the chest, and was also drunk with cocoa to stop hemorrhage." This seems to be the earliest mention of the use of rubber in medicine.

Gutta percha was introduced to the medical world by Mr. Montgomerie, of Singapore, in 1822, who had his attention called to it by the natives using it for whips. Twenty years later he recommended it as a good material for making braces and other surgical appliances. This is its first authenticated use in medicine or surgery. The Chinese and Malays are said to have long known and used it in medicine, though no authentic records of such use exist. It was in 1842 that Mr. Montgomerie, of the East India Company, recommended the use of gutta percha for splints and other surgical appliances to the medical board of Calcutta. In 1844 the Society of Arts, of London, gave him a gold medal in recognition of his useful discovery and its results in the practice of surgery. After the publication of Mr. Montgomerie's valuable paper on gutta percha, this article came rapidly into use for instruments and braces and other surgical appliances.

To come to the present use of these gums, we may refer first to general surgery. India rubber has rendered its greatest service to surgery, perhaps, in the form of drainage tubes. Upon the proper drainage of wounds depends in a large measure their healing. Without drainage of some sort, in fact, most wounds would not heal, while with drainage operations are now undertaken that otherwise would not be attempted. To illustrate in a practical but homely way the importance of drainage to the success of surgery, we may refer to the drainage of low or swampy lands. By means of drainage the excess of water is removed from these swamps, and that land which before was filled with foul water, contaminated with miasmus and without value and uninhabitable, is converted into a dry, healthy and habitable area. So with surgery, where large abscesses are opened, suppurating cavities entered, or even where fresh wounds are made, drainage is absolutely necessary, if we are to expect success. As the drainage of swamp lands makes them habitable and helps preserve the lives of those living in such districts, so the drainage of wounds or abscesses makes it possible now to save lives that would certainly be sacrificed were it not for drainage. In fact, new fields of surgery have opened, simply from the fact that the wounds could be perfectly drained and cleaned properly.

While it is true that many substances, such as metal, glass, animal tissue and vegetable tissue other than rubber, have been and are now used for drainage tubes (some of them long before rubber was known), yet more drainage tubes are made of rubber than of all the others combined. First, its great elasticity renders it applicable to almost any shaped wound; second, it is not easily broken; third, it resists most chemicals; fourth, it is cheap and easily sterilized. The amount of caoutchouc annually consumed in the manufacture of this tubing, and the commercial value of the same, it is impossible to state, but it is very large.

India rubber and gutta percha are employed in many other ways in general surgery. As a tourniquet, rubber serves to check hemorrhage during an amputation. Elastic bandages and stockings are used in the treatment of ulcers and varicose veins. Ice caps, ice bags, coils, hot water bottles, etc., made of rubber are very convenient for use when hot or cold applications are to be made. Rubber sheeting, rubber mattresses, rubber cushions, etc., are constantly used in surgical diseases. Irrigation tubes, stomach tubes, rectal tubes, surgeon's aprons and cushions, gloves, etc., are all made of rubber. Syringes, instruments, instrument handles, instrument cases, etc., are in many instances made of hard rubber, while braces, splints and other surgical appliances of this nature are made of gutta percha.

In genito-urinary surgery, India rubber, hard and soft, finds a large field of usefulness. Its chief use here is in the form of catheters, bougies, syringes, pessaries, cushions, bags, etc. Of the different articles here mentioned I shall confine my remarks, which are quoted in the main from a recent issue of a leading medical journal,* to two articles—catheters and bougies. Relatively the other articles are of almost equal value. Catheters, which are meant for emptying the urinary bladder, have been in use for thousands of years, certainly for two thousand, as those found at Pompeii bear witness. These, however, were metallic. Dr. Gouley, in the journal referred to, says that perhaps soft, pliable catheters were made as early as the eleventh century, but these did not come into general use until the latter part of the last century, and soft rubber catheters not until some years later. I quote him:

"Until recently, France, Germany and England seem to have supplied the greater part of the gum catheters and bougies used in different parts of the world. The first large manufactory of catheters in

* "Notes on American Catheters and Bougies." By J. W. S. Gouley, M.D., New York Medical Journal, July 22, 1893.

England was established many years ago by a German, Mr. Eschmann, whose successors are still engaged in the extensive manufacture of these instruments. About fifty years ago, says Mr. Stohlmann, soft catheters and bougies were manufactured in the United States by a Frenchman, Mr. Petrie, who had established himself in Philadelphia, but soon gave up the business because the demand for his instruments was too limited, on account, perhaps, of their being inferior to those imported from France. From that time it does not appear that any attempt was made to manufacture gum catheters in this country until the year 1879, when Mr. Roy, son-in-law of Mr. Benas, of Paris, established a catheter factory in one of the suburbs of New York, and continued to supply, to a limited extent, the demand for gum catheters until 1890, when his establishment was closed. Thus far the home manufacture of these catheters had affected but little the importation of French, English and German catheters.

"It has not been possible to obtain strictly accurate information relating to the importation, home manufacture and consumption of soft catheters and bougies, but some of the merchants and manufacturers assert that the annual sale is about one million soft catheters, of which two hundred thousand are of India rubber and one hundred and ten thousand bougies. Until the end of 1875 nearly all the soft vulcanized India rubber catheters used in this country were imported. In 1876 the firm of George Tiemann & Co., of New York, began the manufacture of India rubber catheters with countersunk blunt-edged eyes under the name of velvet-eyed catheters, and also some catheters of the same material with no lateral eye, but open at the vesical end. The following named firms have since been engaged in the manufacture of soft rubber catheters: The Davidson Rubber Company; Parker, Stearns & Sutton; the Akron Rubber Company; the Tyer Rubber Company and several other companies. At present, of the two hundred thousand India rubber catheters sold annually in the United States, only thirty thousand are imported."

As to quality of the home-manufactured catheters and bougies as compared with the foreign manufacture, he says:

"These American catheters and bougies are fully equal to those manufactured in foreign countries, and some of them are even superior. The American India rubber catheters are superior to those of foreign importation in the construction of the eye, in the high polish of their surface and in the smoothness of their interior."

In other special branches of surgery, as in the treatment of the eye, ear, nose and throat, we have use for rubber as syringes, atomizers, tubes, specula, bulbs, instrument handles, etc. In gynecology and rectal diseases instruments and articles made of rubber are not only in wide demand, but almost a necessity. These articles, among others, are catheters, bougies, syringes, tubes, cushions, basins, pessaries, bandages, bags, etc.

Finally, in that branch of mechanical surgery known as prosthesis, which has for its object the supplying of artificial limbs, etc., India rubber serves a most useful purpose. Many artificial limbs are made entirely of rubber, while most, if not all, the remainder have rubber in some form—as buffers, elastics, etc.—employed in their manufacture. The artificial hands and feet made by A. A. Marks, of New York, who is one of the largest manufacturers of these goods in America, are of solid India rubber, the feet having a small core of wood. Other manufacturers, of whom there are about thirty in the United States, do not make hands and feet of solid rubber, but employ the rubber in the joints as "buffers" to obviate jar or concussion, and in the sole of the foot also place the rubber for the same purpose. Elastics are sometimes placed about the joints of these artificial limbs to protect and strengthen them, and at the same time render them more mobile. So deftly are the artificial hands made that the wearer can pick up and handle small articles, and can even write, which to a business man may mean his "bread and butter." For the laboring man the hands are so made that they can be detached, and a hook, e. g., the famous Capt. Cuttle's, a knife, a fork, and even tools can be inserted into the arm attachment, and the individual thus enabled to earn his own bread. And so perfectly are the feet made and so comfortably and satisfactorily do they perform their function, that they defy detection in the wearer of them. Not only can the owner follow the ordinary vocations of life, but he can dance, ride the bicycle, etc., and not necessarily without grace and ease. Artificial limbs, unlike artificial eyes, which fill the place of the lost member in an esthetic sense only, actually perform the functions of the wanting members, and almost, if not quite, as perfectly.

Some idea of the enormous number of artificial limbs worn by the veterans of our late war can be obtained by remembering that it requires about thirty government manufacturers to supply the demand, as the government furnishes to soldiers and sailors who lost limbs a new support once in five years.

In medicine, generally and specially, the general practitioner has almost as many uses for India rubber as the surgeon has. From the rubber sheets which he uses to protect the bed at childbirth to the rubber cushions which he prescribes to ease the declining years of the aged, he has constant use for India rubber in some form. Rubber nipples, which at first glance might be thought of but little importance, form a most convenient pap, in this day of artificially fed infants, for the taking of artificial food, milk, etc. Especially is this so in the larger cities, where not only thousands of children in private homes are "brought up on the bottle," but where thousands of children in nurseries, foundling asylums and hospitals are reared in the same way. The society woman has not the time (or inclination, perhaps) to nurse her infant, the workingwoman, of necessity many times, must leave her infant at a day-side nursery, while many mothers, on account of their own health, are compelled to rear their children on the bottle. So that from one reason or another, we find in New York City, perhaps, 25 per cent. of all the children born "bottle fed." Teething rings made of India rubber have their use a little later in the infant life.

Stomach tubes of rubber are often used in the digestive troubles of children for washing out the stomach; as they also are for emptying the stomachs of adults. In the lying-in room, in private and hospital practice, besides rubber sheets, we have use for catheters, syringes, dilators, irrigators, breast pumps, belts, basins, etc., most of which articles are made of India rubber and gutta percha. Again, in any condition in which heat or cold is to be applied, water bags, caps, bottles, coils, etc., made of rubber are in general demand and use. In diseases where bed sores are to be prevented and where great ease and comfort are demanded, beds and cushions of rubber, filled with air or water, serve a most useful purpose.

The introduction of vulcanized rubber into the practice of dentistry marked the greatest epoch in its advancement. A word as to the history of this important branch of medicine may not be out of place here. That the Egyptians had professional dentists the artificial plates of ivory, wood, and even gold, found in the jaws of mummies, bear silent witness. After the Egyptians, however, there is no trace of dentistry until the time of Galen, and no traces of a special dental profession until the middle of the seventeenth century. Not until this century even was dentistry as a distinct profession recognized. With the advent of the process of vulcanization of India rubber, about the middle of this century, the number of men in the dental profession rapidly increased. In 1830 the estimated number of dentists in the United States was 100; in 1890 they were estimated at 14,800!

Vulcanized India rubber as a material for plates to hold artificial teeth has no superior, if, indeed, an equal. It is questionable if gold, which is much more costly, forms a more comfortable or even much more durable plate for artificial teeth. Dr. H. W. F. Cady, an eminent dentist of New York, informs the writer that a properly vulcanized India rubber plate will last for a number of years—twenty to thirty—without being changed by the secretions of the mouth. Besides durability, it possesses another advantage over other material, in that during the process of vulcanization it can be tinted to exactly correspond to the color of the human gums. From an esthetic point of view, in both men and women, this is of much importance. Dr. Oliver Wendell Holmes, in an address delivered in 1872 at Harvard University, speaks pertinently on this point. As to a woman's teeth, he says:

"There is no element of her wondrous beauty which can take the place of white, even, well-shaped teeth. And as beauty is not a mere plaything, but a great force, like gravity or electricity, the art which keeps it, mends it, and, to some extent, makes it, is of corresponding importance."

Another recommendation yet in favor of vulcanized India rubber for plates is its cheapness, which is not its least advantage; for thousands of people who now wear artificial teeth, which contribute to their good digestion, good health and good looks, would be unable to do so were it not for vulcanized rubber, the price of which is within the reach of the masses. Gutta percha is sometimes used for plates in the same manner as India rubber, but to a very limited extent, as it does not wear so well as the India rubber article. Bleached gutta percha however, is used in filling teeth, for which it is very useful when the teeth will not stand a metal filling. The "rubber dam" or sheeting is another article of India rubber much used in the dental profession.

From a doctor's point of view, the teeth, upon which depend a proper mastication of food, and indirectly the digestion and assimilation of the same, hold the key, in great measure, to good health. Consequently, any art which aids in the preservation, care, and even restoration of them, is held in great respect. Pertinent here again is another remark from Dr. Holmes, who makes Walter Savage Landor say: "I have lost my mind, that I do not care so much about; but I have lost my teeth, and I cannot eat." Certainly a pathetic condition! Had he been supplied with a set of artificial teeth, such as are made to-day, his mind would have been a greater loss to him, perhaps, than the loss of his original teeth. Without good teeth, however, there is no such thing as good health. Hence the inestimable service that vulcanized rubber has rendered to mankind already. And, if we are rapidly advancing to that "toothless and hairless age in man" so confidently predicted by some of the most advanced scientists of to-day, it stands to render us still greater service.

It is estimated that sixteen tons of India rubber are annually consumed in the manufacture of plates for artificial teeth.

In the field of hygiene hard rubber is sometimes used in the manufacture of water pipes, faucets, valves, etc., all of which articles have their use in sanitary plumbing.

Soft rubber has even a more extensive use in the manufacture of articles that are employed in the practice of hygiene, both public and private. Mackintoshes, gossamers, rubber shoes and boots, are the most important of these. These articles have to do chiefly with the prevention of disease, which, indeed, is the chief aim of hygiene. They also protect those recovering from disease. The importance of protecting the feet from the damp ground is tersely expressed in a text book by Dr. Bosworth, a leading throat specialist of New York, who says:

"The best chest protector is worn on the sole of the foot. Furthermore, inasmuch as all these articles are for protection and prevention, they may very properly be regarded, so far as health is concerned, that 'ounce of prevention' which is better than the pound of cure."

With reference to the use of India rubber in the practice of army and navy hygiene, I shall content myself with the mention of one article, and that in relation to the army, though it applies with equal force as regards the navy. I quote from an article* by Dr. Alfred A. Woodhull, a surgeon in the United States army, who says:

"A poncho, or India rubber blanket, which is not technically 'clothing,' but 'equipage,' may be issued in the field. This waterproof may completely protect the sleeper from soil dampness, and is, perhaps, the most important single article for the soldier's use."

So throughout the entire practice of medicine, dentistry, and hygiene—medicines excluded of course—with one exception (steel) India rubber is, I believe, the most important single article used by the medical profession.—The India Rubber World.

* "Reference Handbook of the Medical Sciences," Vol. VIII, p. 760.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
361 Broadway, New York, N. Y.

TABLE OF CONTENTS.

PAGE

I. ARCHÆOLOGY.—Greek Papyri in Egypt.—Egypt as a field for the discovery of Greek historical documents 15566
Progress of the Excavations at Delphi.—Grecian antiquities and remarkable finds described 15569
Roman Remains at Bath, England.—Proposed reviving of the ancient Roman bath in the city of Bath.—1 illustration 15569

II. ARCHITECTURE.—The New Protestant Cathedral, Berlin.—A proposed cathedral.—The accepted design.—1 illustration 15563

III. ASTRONOMY.—A Prolonged Sunspot Minimum.—By E. WALTER MAUNDER.—The history of sunspots and of their cycles as far as recorded by astronomers 15569

IV. BIOGRAPHY.—Sir Joshua Reynolds.—The great artist.—His life and achievements and character of his work 15562

V. CHEMISTRY.—New Cellulose Derivatives.—By CLAYTON BEADLE.—A new class of valuable cellulose derivatives and their commercial production and uses.—A most exhaustive paper 15564

VI. FINANCE.—The Cost of the New Navy.—An interesting summary of what the U. S. navy has cost 15560

VII. GEOGRAPHY.—The Gulf Stream.—The origin, action, and movement of the great river of the ocean 15565

VIII. MECHANICAL ENGINEERING.—Wind Motors—Ancient and Modern.—By SYDNEY H. HOLLANDS.—A popular and graphic account of windmills of past and present times, with recent inventions 15561

IX. MEDICINE.—The Use of India Rubber and Gutta Percha in Medicine.—By A. G. DAVIS.—Surgical instruments made of these substances.—Their place in medical, surgical, and dental practice 15573

X. MISCELLANEOUS.—A Visit to the Slate Quarries of Angers.—A picturesque scene.—The excavation of the slate. Description of the quarry and of the work done in it.—1 illustration 15559
Graduate and Post-graduate Engineering Degrees 15560
Paestum, Amalfi, Sorrento.—The interesting relics of ancient Rome found in modern Italy.—Vivid descriptions of scenes in the vicinity of these places.—2 illustrations 15567

XI. NATURAL HISTORY.—Two Curious Animals in the Dresden Zoological Garden.—An Asiatic dog and the genet.—Their near relationship.—2 illustrations 15570

XII. NAVIGATION.—Great Circle Sailing.—By T. MACKENZIE.—A simple method of calculating distance in great circle sailing, with formulæ 15560

XIII. ORNITHOLOGY.—The Nandu—An Ornithological Sketch.—By ADOLF ERICH BOECKING.—Ostriches of the Western hemisphere and their habits and place in the natural scale 15570

XIV. PHOTOGRAPHY.—Apparatus for Transforming Photographs.—An amusing phase of photography, applicable for amateurs.—2 illustrations 15562

XV. SEISMOLOGY.—The Earthquake in Turkey.—Recent shocks felt in Turkey, with destructive effects.—1 illustration 15560

XVI. TECHNOLOGY.—Pneumatic Tires and Reclaimed Rubber.—A business of immense development.—The reclamation of vulcanized rubber 15563
Some Differences Between the English and American Plumber.—Comparison of the old and new country tradesmen and their different conditions 15563

CATALOGUES.

A Catalogue of Valuable Papers contained in SCIENTIFIC AMERICAN SUPPLEMENT during the past ten years, sent *free of charge* to any address; also, a comprehensive catalogue of useful books by different authors, on more than fifty different subjects, has recently been published, for free circulation, at the office of this paper. Subjects classified with names of authors. Persons desiring a copy have only to ask for it, and it will be mailed to them. Address

MUNN & CO., 361 Broadway, New York.

PATENTS!

MESSRS. MUNN & CO., in connection with the publication of the SCIENTIFIC AMERICAN, continue to examine improvements, and to act as Solicitors of Patents for Inventors.

In this line of business they have had *forty-five years' experience*, and now have *unequaled facilities* for the preparation of Patent Drawings, Specifications, and the prosecution of Applications for Patents in the United States, Canada, and Foreign Countries. Messrs. Munn & Co. also attend to the preparation of Caveats, Copyrights for Books, Labels, Reissues, Assignments, and Reports on Infringements of Patents. All business intrusted to them is done with special care and promptness, on very reasonable terms.

A pamphlet sent free of charge, on application, containing full information about Patents and how to procure them; directions concerning Labels, Copyrights, Designs, Patents, Appeals, Reissues, Infringements, Assignments, Rejected Cases. Hints on the Sale of Patents, etc.

We also send, *free of charge*, a Synopsis of Foreign Patent Laws, showing the cost and method of securing patents in all the principal countries of the world.

MUNN & CO., Solicitors of Patents,
361 Broadway, New York.

BRANCH OFFICES.—Nos. 622 and 624 F Street, Pacific Building, near 7th Street, Washington, D. C.